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Metallography—The Microscopic Study of The Structure of Metals

The Value of Metallurgical Science in Industry—Uses of the Microscope—Study of Metallic Structures—Results of Microscopic Examinations

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TO ONE interested in the "why and wherefore" of the behavior of metals, the reasons for the variations of properties under different treatments, or an explanation of the deterioration or failure of materials in service, the use of the microscope is of utmost importance. In fact, the examination of the structure of metals forms so large a part of any metallographic study that by many the two are considered synonymous. It is no longer necessary to advance arguments to show the importance of the metallographic method in the testing of metals. The remarkable growth of the science in the last few years, together with the widened scope of its applications, is sufficient evidence of the value and usefulness. From a relatively unimportant branch of physical chemistry it has been developed into a means of investigation of the properties of metals and alloys that is on a par with the older methods of chemical and mechanical testing, and it is very frequently of service in explaining obscure phenomena which are inexplicable from the results of the other and older methods alone.

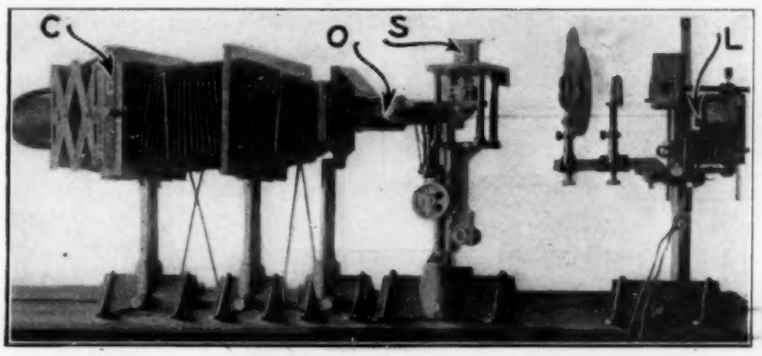


FIG. 1. CONVENIENT FORM OF METALLURGICAL MICROSCOPE

(L) Arc lamp for source of light. (S) Specimen on stage of microscope just above the objective. (O) Ocular for visual observation. (C) Camera for projection for photographic purposes.

Tiemann's[1] definition of the term metallography, as "that branch of metallurgy which treats of the constitution and the structure of metals and alloys and their relation to the physical properties" may be cited as clearly outlining the field covered. However, for a complete metallographic study several other lines of investigation must also be followed in order to establish with certainty both the nature of the physical constituents and the relation which they bear to the physical properties. Thus for example, we need thermal analysis, magnetic analysis, mechanical testing and, of course, chemical analysis. In the present article, however, the discussion must be limited to the structure of the metals and the means of identification of the constituents, together with some typical references to the effect of these upon the properties of the metal itself.

On account of their nature, the microscopical examination of metals cannot be made so easily nor so readily as most other microscopical work. One cannot prepare a section of any metal thin enough to transmit sufficient light to make possible examination in the usual manner by the transmitted light. Instead, the examination of the surface of the specimen must be carried out by means of reflected light, and the apparatus must be constructed with this in view. The principal change which this involves is the insertion of a device in the tube of the compound microscope by means of which light is admitted in the side of the microscope tube and reflected through the lens upon the surface of the specimen to be examined.

Some auxiliary devices are necessary, of course, such as a powerful source of light for lighting the specimen, with suitable means for focussing the beam and controlling its intensity, means for leveling the specimen, facilities for photographing the image so that a permanent record may be made, etc. The apparatus may be made more or less complicated according to the number of such accessories which are added. The most convenient and also the most used form of instrument is that commonly designated as the "inverted microscope." This term means that the stage upon which the specimen is placed is located above the lens rather than below it, as in the usual form. Such an arrangement

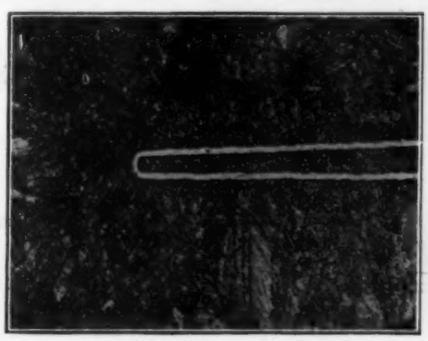
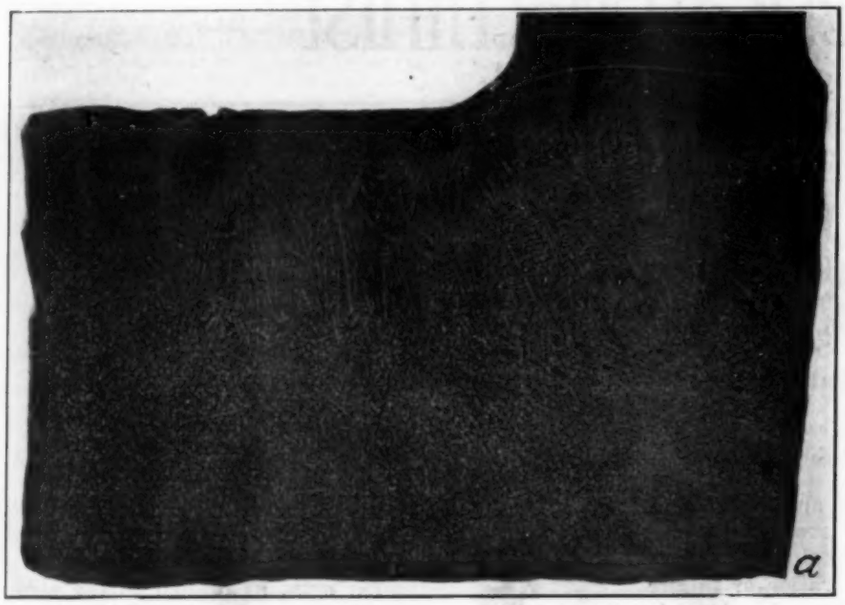
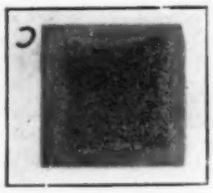
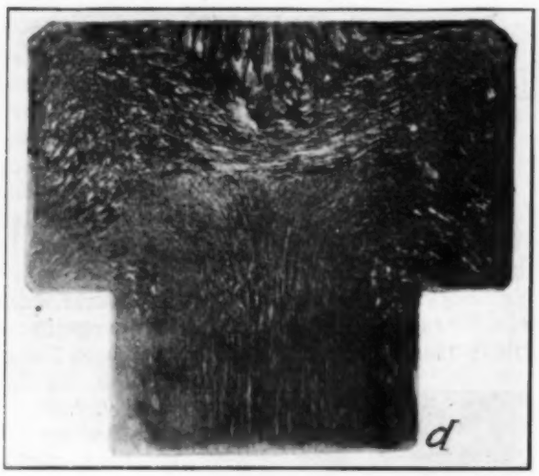


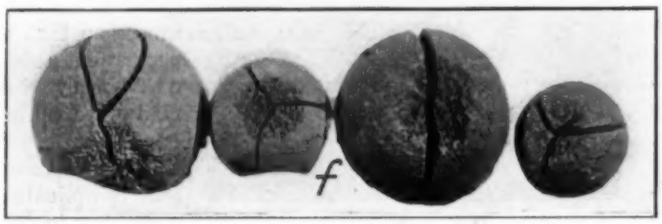
FIG. 2. METHOD OF PREPARATION OF VERY SMALL METAL SPECIMENS FOR MICROSCOPIC EXAMINATION. (× 100)

[1] H. P. Tiemann, "A Pocket Encyclopedia." "Steel and Iron"; McGraw-Hill Co.









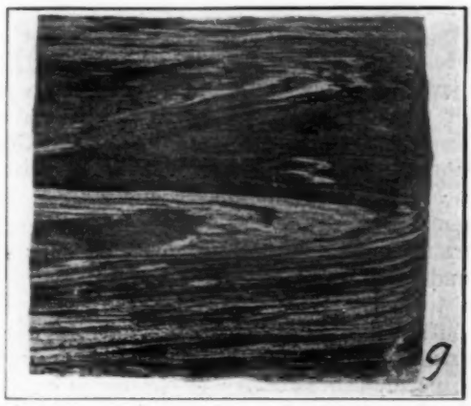


FIG. 3. TYPICAL MACROSTRUCTURAL FEATURES OF ALLOYS

(a) Defective steel casting deeply etched with hot concentrated hydrochloric acid. (× 1.) (b) V-weld in steel plate produced by the oxyacetylene process; etching reagent. (× 1.) (c) Cross-section of a steel bar, the mechanical working which the material received in reducing from the ingot to the size shown was not sufficient to remove the unhomogeneity due to segregation in the ingot. (× 1.) (d) Longidutinal section of a manganese bronze bolt which failed in service. (× 1.) (e) Crystalline structure of wrought iron revealed by etching with ammonium persulphate. (× 3.) (f) Hardened steel balls etched with hot concentrated hydrochloric acid to show process of manufacture. The etching also revealed the presence of high internal stresses caused by the severe hardening treatment. (× 2.) (g) Wrought iron etched with hot concentrated hydrochloric acid shows the additions (light streaks) of steel to the material. (× 1.)

is very convenient, in that the specimen, prepared as described below, is placed upside down above the opening in the stage over the lens; thus it requires no other leveling or adjusting. A rather complicated system of reflectors within the body of the instrument is necessitated by this arrangement, but the results obtained amply justify this complexity. Fig. 1 shows a microscope of this form with the usual accessories and with a specimen in place. The light *L*, properly directed by the lenses and shutters, is focussed on the bottom of the specimen *S*, which is observed through the eyepiece *O* or photographed by the camera *C*.

A preliminary rough examination of a rather large area is always desirable before proceeding to the finer details of structure. This examination is usually made without the use of the microscope and is termed a *macroscopic* examination. A surface of at least several square inches, and often a complete cross-section of the piece, for example a rail, is smoothed by means of a file and examined after suitable etching. Features such as chemical unhomogeneity, the result of segregation of similar causes, crystalline heterogeneity, mechanical nonuniformity, and physical unsoundness may be revealed. Very special methods may often be employed in this preliminary examination, which at times may become

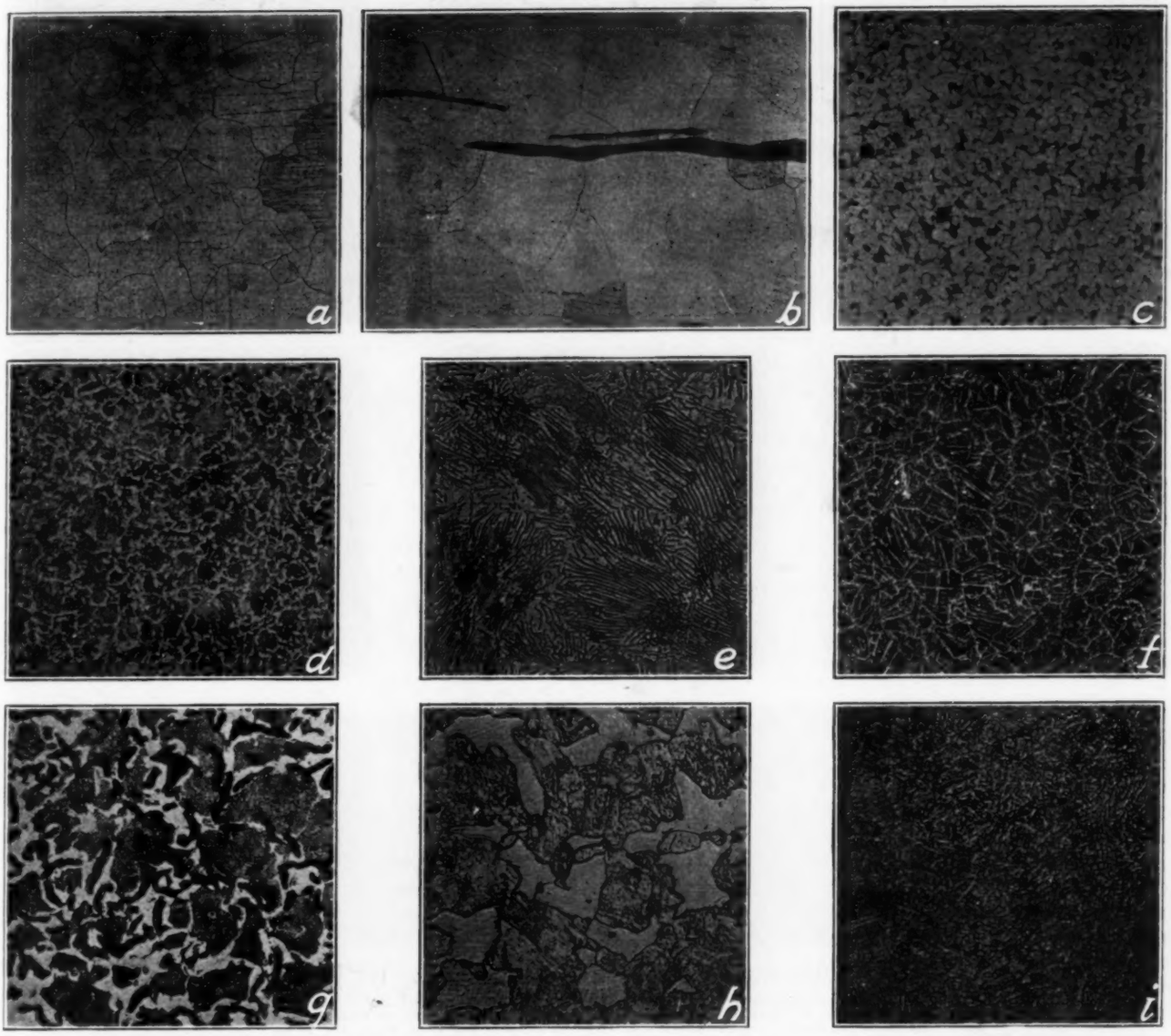
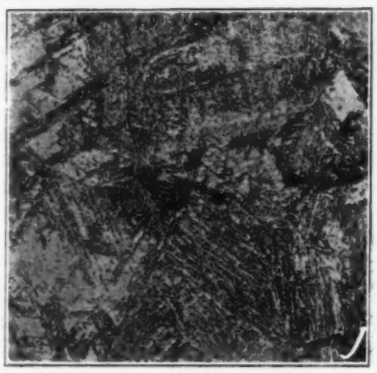


FIG. 4. MICROSTRUCTURE OF TYPICAL IRON-CARBON ALLOYS

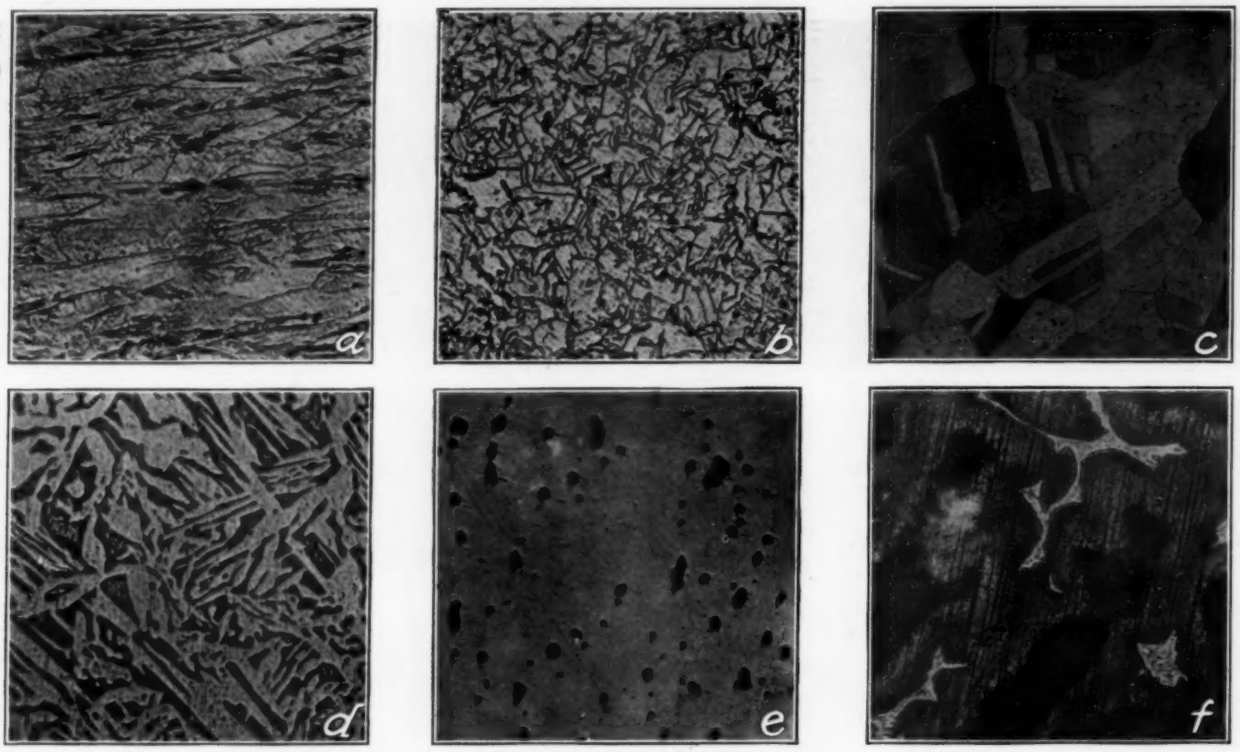
(a) Pure iron, ferrite. (× 100.) (b) Wrought iron showing a slag streak. (× 100.) (c) Steel containing 0.24 per cent carbon. (× 100.) (d) Steel containing 0.50 per cent carbon. (× 100) (e) Steel containing 0.85 per cent carbon. (× 500.) (f) Steel containing 1.45 per cent carbon. (× 100.) (g) Gray cast iron, consisting of graphite flakes embedded in a ferrite-pearlite matrix. (× 100.) (h) Steel, 0.50 per cent carbon quenched in water after 15 minutes' heating at 760 deg. C. (1,380 deg. F.) the material has not been fully hardened. A considerable amount of ferrite still remains in the form of the free constituent. (× 500.) (i) Same steel as (h), properly hardened; quenched in water after 15 minutes at 850 deg. C. (1,515 deg. F.). (× 500.) (j) Same steel as (h), quenched in water after 15 minutes at 1,200 deg. C. (2,190 deg. F.). The metal is coarsely crystalline because of the overheating and numerous intercrystalline cracks have formed. (× 100.)

very much more than "preliminary." For example an examination by means of X-rays of pieces thin enough to permit this method of examination often reveals interior defects which could be detected by almost no other means.

In most cases the subsequent preparation of the specimen for microscopic examination is a rather simple matter. A piece is cut from the material to be examined, advantage being taken of the results of the microscopic examination so that it is so chosen as to be representative of the whole. In some cases it may be necessary that several specimens be examined to insure a representative one being chosen. One side of the specimen in flattened, first preferably by filing and then by a series of stages of grinding, emery paper of an increasingly finer grade being used in each succeeding stage. The surface is finally ground on wet, rotating cloth-covered disks with very fine abrasives (emery flour) and finally is polished on another similar disk which is sprayed with a suspension in water of very fine alumina or of rouge (iron oxide). No attempt is ever made to give the surface the bright finish obtained by buffing, for example, in jewelry, table silverware, metallic mirrors, etc. In fact, this is avoided, since the true structure of a metal is not revealed so well by such means as by the series of grindings (cutting) outlined above.



A specimen approximately ½ in. square is the size usually desired, although very much smaller ones may be used if necessary. Pieces even as small as lathe



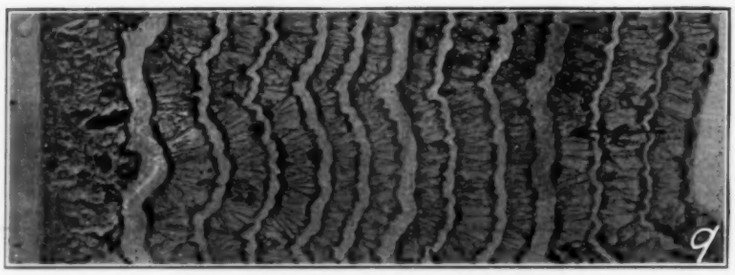


FIG. 5. MICROSTRUCTURE OF COPPER AND SOME OF ITS ALLOYS

(a) Cold-rolled copper, longitudinal section. (× 100.) (b) Same as (a); cross-section of specimen. (× 100.) (c) Brass, 6 per cent zinc, annealed after being cold worked. (× 100.) (d) Brass, 38.5 per cent zinc. (× 100.) (e) Brass to which lead has been added to render it free cutting in the lathe; unetched. (× 100.) (f) Cast bronze, 88 per cent copper, 10 tin, 2 zinc. (× 100.) (g) Cross-section of sheet of metal consisting of alternate layers of electrolytic copper and nickel (light colored). (× 100.)

turnings, or very fine wires, may be suitably prepared. This is conveniently done by heavily electro-plating the small pieces with a deposit of metal (usually copper) and then cutting a section through the resulting duplex specimen, generally after it has been mounted in some sort of matrix (low melting alloy, solder, etc.) for convenience in holding. Fig. 2 shows a specimen prepared in such a way. The strip of copper which in the photo looks like a hairpin was slightly more than 0.001 in. in thickness. In this case an initial layer of nickel was deposited on the surface in order to outline the specimen more clearly. This method is considerably used also for the examination of a metal up to the extreme edge of a flaw or break. The protecting layer of electro-deposited metal serves to hold up the edge during the processes of grinding and polishing, otherwise the extreme edge would be bevelled and rounded off so that it would be impossible to obtain a "fine focus" on such points.

The attempt has been made to develop a method of examination of the material in place so that no cutting of the materal would be required. For this method a spot is polished on the surface to be studied and the examination is made by means of a portable microscope especially designed for the work. However, the method is suitable only for rough work, particularly for preliminary examinations. Furthermore, it has the obvious disadvantage that structure of only the surface metal can be examined, and in many cases this is quite different from the interior.

In a few metals and alloys some features of the structure can be seen on the surface when they are simply polished, as above described; this is due to the differences in color or to the slight "relief" after polishing caused by the difference in appearance or hardness of the various constituents. In by far the greater number of metals, however, the surface must be suitably etched after polishing to reveal the structure. The etching re-agents used differ according to the nature of the metal and the features which are to be revealed. The re-agents so used are numerous. Naturally they must have a slight solvent action upon the material, for example, very dilute acids in the case of steel, ammoniacal solutions for copper and its alloys, etc., but it is the differential attack upon the various constituents or upon the different crystalline grains made by the etching re-agent which reveals the internal "make-up" of the metal.

The details revealed depend largely upon the revolving and the magnifying power of the combination of lenses of the instrument. The magnifying power is usually expressed in linear diameters; by this is meant that any linear dimension would appear increased as many times as the magnification number, for example, a magnification of x 100 would show a line of 0.01 in. length as if it were 1 in. long. The magnification is generally taken as that of the image projected upon the photographic plate.

Magnifications not exceeding 500 are usually sufficient

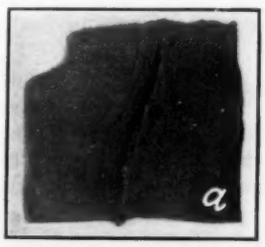
for most examinations, 100 being commonly used; but in some special cases higher magnifications are necessary, for example 1,000 or even 1,500. Examinations with magnifications greater than these rarely reveal any features which cannot be seen at the lower ones.

Some of the features which may be revealed by a suitable microscopical examination are shown in Fig. 3, these being photographs of several typical alloys. It is quite evident that the knowledge of the gross structure of these alloys gained by this preliminary examination is very helpful in properly understanding the more minute features revealed by the microscope in exactly the same way that a knowledge of the anatomy of the human frame must be used as a background in which to fit the information gained by a minute study of the histological features of the various tissues making up the framework. Fortunately, however, in the case of metals, the various "tissues" are very limited in number as compared with those making up the body of the common plants or animals.

Crystalline Nature of Metals

An old-time fallacy which still persists in the minds of some is that metals "crystallize" under certain conditions of service, particularly "fatigue." It simply happens that certain types of fracture, for example "fatigue" breaks, may reveal the crystalline condition more strikingly than others do.

The process of solidification of metals is one of crystallization and the metal remains crystalline throughout all subsequent treatments, either mechanical and thermal, to which it may be subjected. The form, size, and perhaps other characteristics of the crystals vary, but the material is always essentially crystalline. Certain metals appear to have a fibrous structure, due to the inclusion of certain non-metallic substances (slag); the metal itself is crystalline, however. To be sure, the crystals of metals lack the definite symmetrical form which this term usually suggests to us; but this is only on account of their manner of formation. By suitable means crystals of metals showing a very definite geometrical form may be secured.



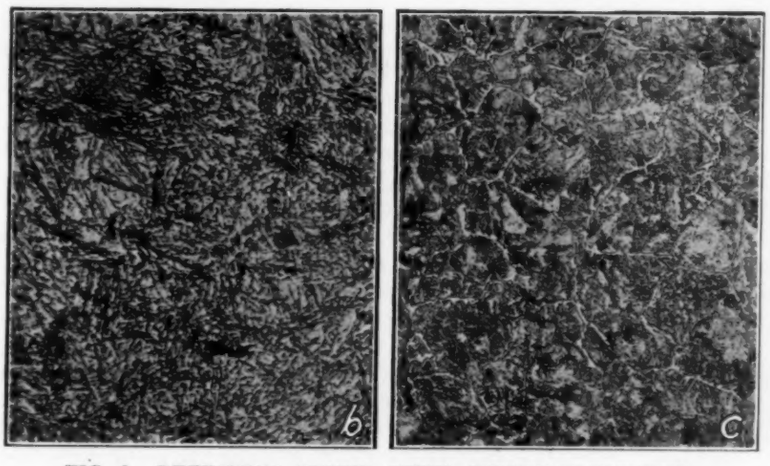


FIG. 6. DEFECTIVE NICKEL STEEL WHICH PRESENTED DIFFICULTIES IN MACHINING

(a) Longitudinal section of forging deeply etched with hot concentrated hydrochloric acid to show hard center. (× 1.) (b) Martensitic structure of the hard core which was of high nickel content. (× 500.) (c) Pearlite-ferrite structure of the outer (normal) portion. (× 1.)

Fig. 4 shows the microstructure of iron and several typical iron-carbon alloys (steels). These micrographs illustrate the crystalline condition which obtains in metals, the constitutional changes which result from changes in chemical composition, as well as structural changes resulting from certain treatments. For the complete study of any alloy system constant reference to the equilibrium or constitutional diagram for that particular system should be made. A discussion of this point is impossible here, however. Alloys such as steels which exist in different structural states at different temperatures, or which show the phenomenon of "critical transformations," may upon heating exist in conditions which are widely different from those ordinarily observed in the alloy. For example, if a steel is cooled very suddenly from a temperature above the critical transformation, the structure normally existing in the metal when above the critical temperature will be retained, at least in part, by the cooled alloy.

Profound changes of the properties of the steel also accompany this structural change. The alloy is in a state of unstable equilibrium and if given a chance, as may be done by gently heating, it will gradually tend to return to a state of stability which is the normal one for ordinary temperature. These changes constitute the tempering and annealing of steel, processes which involve profound changes of structure as well as in properties of the material.

The most useful application that has been made of the microscopic study of metals is in the field of heat-treatment of steels. The development of the alloy steels and the treatment necessary for developing their best properties may safely be said to have been rendered possible in a very large degree by the intelligent study of the microstructure of these materials.

The process of heat-treatment, however, is not peculiar to steel, but applies to all alloys which exhibit transformations at some temperature. The light alloys of aluminum are samples of other alloys to which this applies.

Fig. 5 shows the structure of copper and some of the industrial alloys of this metal and emphasizes the fact that the structural condition may be influenced to a marked degree by the physical state of the alloy, that is, whether cast, wrought or annealed.

Fig. 6 illustrates a typical practical application of the microscopic examination of metals. The specimen shown was a forging for a rifle part made of the usual 3½ per cent nickel steel. It was found to be impossible to drill out the center of many of the specimens of a particular lot. The examination showed that the metal composing the core of the piece, even when the forging was in the annealed state, was "martensitic" in structure although the greater part was in the "ferrite-pearlite" condition. It was then plainly evident that the trouble had arisen in the manufacture of the steel, the nickel not being uniformly diffused throughout the melt. Thus it was proved that it would be impossible to better the condition of the forgings very materially by heat-tratment or by any other processes short of remelting. Subsequent chemical analysis of the core confirmed the conclusion drawn from the microscopic examination and showed that the nickel content of this portion was high

enough to render it martensitic although the average nickel content of the specimen as a whole was not far above that desired.

Lack of space prevents further detailed reference to applications of the structural examination of metals. However, some of the purposes for which examinations of this kind may be made are summarized herewith.

(1) Supplement to chemical analysis. A preliminary survey will often show how and where samples for the chemical analysis of a metal should be taken in order that they may be representatve of the piece. The relative magnitude and nature of portions too small to be sampled separately, as for example, metallic coatings, may be demonstrated. The form in which different chemical constituents occur throughout a metal, as distinct constituents of a definite composition, or as "foreign" inclusions which do not truly form a part of the metal or alloy, can also be determined.

(2) Relation to heat-treatment. The microscopic examination is often necessary to show quickly whether a steel has received the proper treatment, and if not what change should be made in order to produce a better structure and better properties. Some processes such as carburization can be investigated only by means of the structural examination, others, for example annealing and grain refinement of large forgings, are also most readily controlled by this process.

(3) Metallurgical processes and materials. In certain cases the examination of the structure is the only sure method of determining what the real nature of a material is and the process by which it has been manufactured. Wrought iron may be cited as an example. The nature of the mechanical treatments given a material may often be revealed by a suitable examination, and the efficiency of the treatment determined thereby.

(4) Service deterioration of alloys. The gradual deterioration which occurs in some alloys in service, for example the swelling and cracking of certain zinc alloys, can often be best remedied after a careful examination of the structure has been made. Thus it is possible to determine the "mechanism" by which deterioration occurs, so that a suitable remedy can be suggested.

(5) Failure of metal parts. In the "post-mortem" study of failed metals, the microscope plays a very important part. The determination of the most probable cause of the failure requires a broad knowledge of the manufacture, properties, and structure of metals, both sound and unsound. The structural examination forms an essential part of the examination and is often the most enlightening of all.

(6) Relation to mechanical properties. Inferior mechanical properties of a material shown under test are often explained by a structural examination of the test bars. The microscopic examination is of particular value in such cases.

(7) Structural diagrams of alloy systems. These diagrams are of fundamental importance in the study of alloys and the microscopic examination plays an important part in their determination.

In addition to the above, the structural examination aids in a great many miscellaneous ways, each particular specimen taken up having characteristics peculiar to itself. The study of the structure of metals is, indeed, a most fascinating one. In the above discussion, however, the attempt has been made to present only a few "practical" aspects of the subject rather than the academic or strictly scientific phases.

Power and Fuel Used by Machine Shops and Foundries in "Superpower Zone"

By H. Goodwin, Jr.

All engaged in the machine industry know the great progress of electric drive in the past year and of its accelerated progress in most recent years. Shops supplied with energy by a large central station know its convenience and economy. Other industries have been progressing in like manner though the machine shop is quite in the lead. This is because of the fundamental and evident economies of the application of purchased power to this industry. Statistics show that the largest as well as many of the smaller shops place reliance almost entirely upon purchased electric power and are continually increasing the proportion.

This development led to the questions: "What should be the ultimate logical development of the central stations to carry all the industries and railroads that could economically be so electrified? What would be the conservation of our fuel thereby?" A comprehensive electrical "Superpower System" was proposed for the North Atlantic Seaboard, "the Finishing Shop of America." A special survey under the U. S. Geological Survey was made to determine the feasibility and economy of the scheme and the report will shortly be issued.

The Census Bureau co-operated and prepared in advance some statistics in special form on all the different industries. Much of this is of great interest to the machine industry and some of it is here presented. The table gives, in a new analytical form, the use of power and fuel in machine shops and foundries. Some shops that would come under this general classification have been separated for particular purposes and will be shown individually in the Superpower Report. Such are: blast furnaces, rolling mills, locomotive factories, vehicles, railroad repair shops, electrical machinery and shipbuilding. But the table here presented is typical and covers the great mass of machine shops and foundries.

The table is in great detail, but a little attention should make its meaning clear. The column headings under "Power Supply Equipment" are all self-explanatory. The "Electric Motor" summary indicates the degree to which the industry has been electrified and includes the "Electric motors operated by purchased energy" in the preceding columns. Under "Fuel Used" the "Total Equivalent Bituminous" should be explained. The proportion of anthracite and bituminous varies in different groups, so it is necessary to reduce them to common terms. Careful investigation including all factors showed that on the average one long ton of anthracite as burned by the industries was equivalent to 0.9 short ton bituminous. This factor was applied and the "Total Equivalent Bituminous" determined.

Looking back, now, to the first two columns of the table, the features of most particular interest are found. The bottom line shows the grand total of power and fuel for the machine and foundry industry, and above it is separated into four different groups of plants, those using (1) no power, (2) steam power only, (3) purchased electrical power only, (4) all other power. The sub-total for each group is given and each is then separated into three other groups by plant size, the dividing lines being 200 hp. and 500 hp. total installed capacity. It is to be noted that these divisions have been carried right through the power equipment and fuel, so that the amount of fuel associated with any group of

POWER AND FUEL USED BY MACHINE SHOPS AND FOUNDRIES

Grouped by Character of Power Supply from Data of 1919 Census of Manufactures

Character of Power Supply	Plant Size, Hp.	Establishments			Power Supply Equipment													Electric Motors			Fuel Used			
					Prime Movers																Coal			
							Steam Engines		Steam Turbines		Internal Combustion Engines		Water-Wheels		Operated by Purchased Energy									
		No.	Average, Hp.	Aggregate, Hp.	Total, Hp.	No.	Hp.	No.	Hp.	No.	Hp.	No.	Hp.	Total Hp.	Electric Motors No.	Electric Motors Hp.	Other Hp.	Total No.	Total Hp.	Run by Current Generated in Establishment, No.	Hp.	Anthracite, Long Tons	Bituminous, Short Tons	Total Equivalent Bituminous, Short Tons	Coke, Short Tons
No power		407	....	.....	.....	....	.....	...	.....	...	.....	...	.....	.....	.....	.....	.....	.....	.....	.....	.....	4,230	3,304	7,114	1,077
Steam power only:																								
	1-200	452	71	32,166	32,166	535	31,713	9	453	....	.....	....	.....	.....	.....	.....	.....	1,213	8,713	1,213	8,713	69,628	153,924	216,564	48,561
	201-500	87	333	29,030	29,030	174	27,045	16	1,985	....	.....	....	.....	.....	.....	.....	.....	1,900	19,738	1,900	19,738	40,664	105,987	141,987	24,465
	501 and above	72	1,920	138,052	138,052	337	70,878	79	67,174	....	.....	....	.....	.....	.....	.....	.....	9,491	133,800	9,491	133,800	243,808	598,265	817,865	113,638
	Sub-total	611	326	199,248	199,248	1,046	179,636	104	69,612	....	.....	....	.....	.....	.....	.....	.....	12,604	162,251	12,604	162,251	354,100	858,176	1,176,416	186,664
Purchased electric power only:																								
	1-200	3,701	26	95,580	.....	....	.....	...	.....	...	.....	...	.....	95,580	13,971	95,580	.....	13,971	95,580	.....	.....	66,177	102,742	162,242	109,625
	201-500	142	312	44,489	.....	....	.....	...	.....	...	.....	...	.....	44,489	4,158	44,489	.....	4,158	44,489	.....	.....	24,835	58,478	80,778	31,114
	501 and above	103	1,050	118,676	.....	....	.....	...	.....	...	.....	...	.....	118,676	10,144	118,676	.....	10,144	118,676	.....	.....	32,453	147,478	176,578	63,708
	Sub-total	3,946	655	258,745	.....	....	.....	...	.....	...	.....	...	.....	258,745	28,273	258,745	.....	28,273	258,745	.....	.....	123,465	308,698	419,598	204,447
All other power:																								
	1-200	1,341	40	54,293	38,753	319	16,741	7	286	960	15,827	167	5,899	15,540	1,654	13,033	2,507	2,331	17,617	677	4,584	43,195	101,056	140,056	38,735
	201-500	165	320	52,501	32,872	215	24,069	12	785	56	2,978	75	5,040	19,629	1,726	19,454	175	2,686	30,564	960	11,110	40,088	137,558	173,558	39,182
	501 and above	155	2,290	354,363	208,708	465	111,465	54	77,578	63	10,622	71	9,043	145,655	9,093	145,455	200	14,068	206,497	4,975	61,042	152,280	931,306	1,068,000	95,199
	Sub-total	1,661	278	461,157	280,333	999	152,275	73	78,649	1,079	29,427	313	19,982	180,824	12,473	177,942	2,882	19,085	254,678	6,612	76,736	235,563	1,169,920	1,381,614	173,116
Total (power)		6,218	148	919,150	479,581	2,045	281,911	177	148,261	1,079	29,427	313	19,982	439,569	40,746	436,687	2,882	59,962	675,674	19,216	238,987	713,128	2,336,794	2,977,628	564,227
Grand total		6,625	....	919,150	479,581	2,045	281,911	177	148,261	1,079	29,427	313	19,982	439,569	40,746	436,687	2,882	59,962	675,674	19,216	238,987	717,358	2,340,098	2,984,744	563,304

prime movers or motors can immediately be determined.

Several interesting comparisons can be made. The total horsepower of plants purchasing all their energy is considerably greater than those depending on steam only, being 258,745 hp. as against 199,248 hp. The coal used by the former is 419,598 tons per annum (for other purposes than power development, such as heating) is 1.6 tons per hp., while the latter use 1,176,416 tons, or 5.9 tons per hp. Figuring that a modern central station can supply the motors by burning 1 to 1.5 tons per hp. per year shows great economy in favor of the central station. The same method may be applied to each line in detail, showing for the industry, by and large, the great economies possible.

Attention is invited to the fourth column, showing the average horsepower size of the plants. The average for all groups is 148 hp. This compares with 110 hp. for all industries. The average size of units is not given but may easily be determined. There are 2,045 steam engines with total capacity of 281,911 hp., giving an average size of unit of 138 hp. In all industries there are 33,379 steam engines with a total of 4,255,868 hp., giving an average size of unit of 128 hp. These comparisons can be carried on through the various size plants showing small average size units in even the largest plants and lack of reserve in many other plants, etc.

These and other data presented by the reports should be welcomed by the industry as showing in considerable detail the general average condition of the industry today and pointing the way for future progressive development.

Traffic in French Morocco Handled by Motor Trucks

It is interesting to note the development of improved means of transportation, says the *Farmers' Journal*, a publication devoted to the agricultural industry in East Africa. Owing to the absence of railroads, the greater part of traffic in French Morocco is carried on by motor trucks of 3½-ton and 5-ton capacity. Because of the wide extent of the country and the difficult nature of some of the roads, combined with long distances from service stations, the outstanding factors of trucks considered for transportation uses in that country are, above anything else, reliability and service. It is desired that extra-size gasoline tanks and a box for spare parts be incorporated in the truck. It should have a cooling system of extra capacity because of the extremely high temperature encountered. Particular attention to spring suspension should also be given, owing to the weight of loads carried and the poor condition of many of the roads.

European Aerial Lines

Twenty aerial lines, with a total length of 6,000 miles, are in operation in Europe. France holds first place, with lines covering 2,900 miles; Germany comes second, with 2,000 miles; and England third. In addition to these lines there are many local lines, in which Italy leads with 1,260 miles. There are plans for further development of the European aerial system, especially on the part of the French, who are anxious to establish a line between Paris and Constantinople and one between Paris and Toulouse, the latter to form part of an international line 1,800 miles long.

Economic Cycles

Business Cycles Have Long Been Recognized but Not Understood —How They Operate—Elastic and Inelastic Demand

By ERNEST F. DuBRUL
General Manager, National Machine Tool Builders' Association

ONE cause for frequent business failures is the lack of knowledge by many business men of the inevitable occurrence of cycles of prosperity and depression. Business men who do not study the economics of business cycles are always much surprised when a depression comes on.

In 1776 Adam Smith published the first comprehensive survey of economic theory when he brought out his book, "The Wealth of Nations." His book has been a classic ever since it came out. It set out fundamental principles that have been confirmed, though more clearly and definitely analyzed, from year to year as more and more light was thrown on the operation of economic forces.

Adam Smith recognized the operation of the business cycle. Following Adam Smith, David Ricardo, a retired banker, wrote on "The Principles of Political Economy," and he, too, recognized the occurrence of cycles in business. He commented on the fact that most men over-estimate the height of an economic wave and also over-estimate the depth of an economic depression. Few men realize that the economic cycle is fundamental in human and physical nature.

The slump after the boom is caused by overproduction in the economic sense. Not that people do not want, or do not desire all the goods that were produced, but economic demand, which is demand backed up by purchasing power, becomes restricted by the high prices which demand itself created at the height of a boom.

Price is the regulator of both supply and demand. When prices are high, supply is increased to get the profit supposed to exist at the price. At the same time, demand is decreased because of the high price. In the same way, when prices are low demand is increased because of the low price, but supply is decreased. The economic balance between demand and supply is continually wavering; it is as changing in its general characteristics as the waves of the ocean. Even if for one given kind of manufactured goods supply and demand were so thoroughly adjusted that one would exactly meet the other at any given moment, we would still have the economic cycles, due to such variations in crops from year to year as depend on weather conditions.

Exchange Basis of Economic System

All of our economic system is based on exchange of product for product. Money is merely the medium of exchange, and price measures in money the exchange value of one man's bodily, mental, and moral effort in making a product or rendering a service which he exchanges for that of another. When there is large production there is more product to exchange, and all are better off than when the total production is small.

Manufactured goods are produced very largely in advance or in anticipation of demand. The more complicated the process of manufacture, the further ahead must provision be made so that the estimated amount of goods required will be brought to the consumer at the time when it is estimated he will have other products or services to exchange for these goods.

It is manifestly impossible to exactly gage the total quantity of automobiles, hats, shoes, or other consumption goods that can be exchanged for the crop of a given year. If the crop is exceedingly large it will create a large demand. If the crop is small, and the stock of manufactured goods is too large for the farmer's purchasing power, the market then will become glutted, and the manufacturer must wait for the market to absorb the surplus.

Economic Discussion Valuable

Economic discussion clarifies fundamental theories of price and the relation of price to supply and demand. In actual practice there are many variable forces of different kinds that are in operation at any one particular time, so that many people sometimes think that economic theory is all wrong. We hear a lot of loose talk about supply and demand and their effect on price, but many men who use the words do not really have a very clear conception of the operation of the laws of supply and demand.

It is well known that demand for some commodities decreases very rapidly with relatively small increases in price, and conversely, relatively small decreases in price greatly stimulate the demand for such commodities. In economic terms this is expressed by saying that such commodities have an elastic demand schedule.

Many people do not realize that other commodities are subject to an inelastic demand schedule, and that at some prices demand for the same commodity may be very inelastic, though at lower prices it may be very elastic. Every demand schedule could be plotted on a curve if the full information were available.

In the upper ranges of prices even elastic demand schedules become inelastic; that is, there are some people who will buy butter no matter what the price is, and relatively large increases in price in the upper ranges do not greatly diminish this limited demand. In the lower ranges every small increase in price greatly decreases the demand, and conversely. When butter is up in the high ranges small decreases do not greatly stimulate demand, but as prices come down lower and lower every small decrease greatly increases the demand.

On the butter curve there are some points where the inelasticity is very decided, and other points where elasticity is very marked.

There are other commodities in which demand is inherently extremely inelastic; that is, demand is not greatly affected by mere price variations. Coffins would be a very good illustration of inelastic demand. How many more coffins would this country use if they were sold for half their present price? Coffin con-

sumption is not dependent on price reduction—it depends on the number of deaths. There cannot be any speculative buying of cheap coffins by the consumer. There have been times when undertakers speculatively bought coffins ahead because they were relatively cheap and being temporarily sold below the cost of production. Even under such circumstances, however, coffins being subject to change in style, this speculation is extremely limited.

Even in the coffin business there are cycles, because more people die in winter and spring than in the summer and fall. Coffins also have larger cycles that actually conform to the general business cycles. Mortality statistics show that fewer people die per thousand of population in hard times than die in good times. The explanation given for this curious situation is that in hard times people live more carefully and more morally; they do not over-eat, and they do not rush themselves to death. Whatever the reason, the fact remains, so that a coffin business has to be operated in accord with major and minor cycles if it is to be successful.

Handling Elastic and Inelastic Demand

A business dealing with an article having an elastic demand must be handled quite differently from a business dealing with an article subject to inelastic demand. Just as demand is elastic and inelastic according to the nature of the article, so is supply. The coffin busness, for instance, is one that practically has to carry a full organization over the summer and fall periods of inactive demand in order to be able to supply the big demand in the winter and spring. Any sudden call for coffins during the summer and fall can be easily taken care of. Yet when the influenza epidemic created a sudden and very much larger peak demand for coffins there was a relative shortage of supply at that time. The coffin factories had to work night and day, going out and getting all kinds of help wherever they could.

There were some coffin manufacturers who overestimated the influenza epidemic, and when the epidemic was over they found themselves loaded up with material and trimmings that they had overbought. Some of them, perhaps, found their finances strained, because of this excess of stock on hand, and they perhaps tried to realize on this stock by getting cash to replace the stock. If they offered low price coffins in exchange for cash, some undertakers were able to speculate a little by buying coffins below the cost of production. When their own storage facilities were filled up and their financial resources were used up the undertakers had to stop buying. Even lower prices could not have induced additional buying. Then the coffin factories were relatively dull till this over-production was used up. Every business has its own problems due to its own conditions of supply and demand. Mass production with low costs enables one to reach more and more buyers of automobiles and to build a large and profitable business on that condition, but the man who would try it in coffins would spill his financial brains by trying to butt through an economic stone wall.

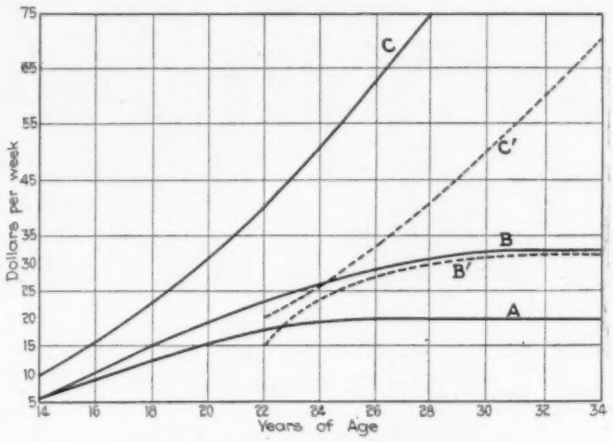
That all seems to be very plain, yet some coffin makers have been known to try to stimulate their business by making low prices with the idea of increasing their volume. And the sheriff's flag was hung out in front of the factory.

What Are the Worker's Prospects in the Machinery Building Industry?

By A. W. Forbes

There have been a great number of articles lately about reducing wages and salaries in our shops, statements that wages must come down, and replies by labor organizations that they are still below what they should be, but very few of the articles are specific as to what they consider a fair wage.

I have prepared the accompanying chart showing my views as to what wages should be expected in the



WAGE RATES IN THE MACHINE SHOP

machinery manufacturing industry, showing the increases that should be expected by various classes of boys.

Curve A: A dull boy but not a defective starting machine work at 14 years of age.

Curve B: An average boy starting machine work at 14 years.

Curve C: The exceptionally bright boy starting machine work at 14 years.

Curve B′: An average boy entering the machine industry after graduating from college or technical school.

Curve C′: The exceptionally bright boy entering the machine industry after graduating from college.

Curve A′ is not given, as a dull boy can not get through college, at least not the grade of dullness which is represented by curve A, the one who will spend his life as a machine operator.

Curve C might as well be omitted as all of this class go through college. This is the class from which our great leaders of industry have come in the past. Now they find a way through college some way even if they have to pay all their expenses and contribute to the support of a family at the same time.

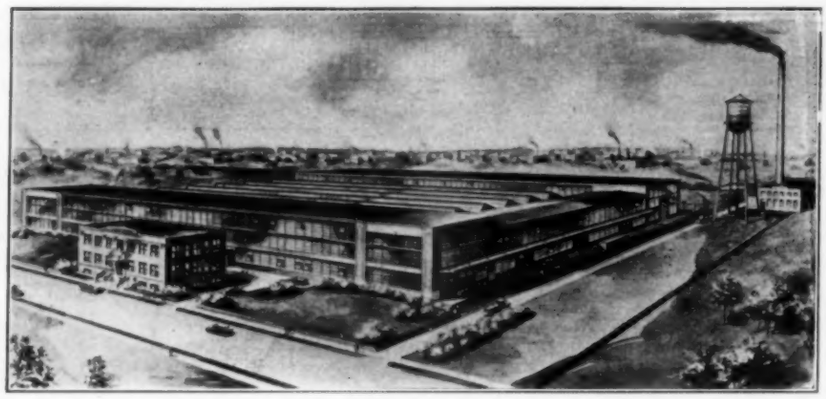
It will be noted that I have drawn the curves for the college or technical school graduate consistently below those for the boys of the same ability who start work at 14 years of age. Many will disagree with this, but I am satisfied that whatever the advantages of the college education are, they do not increase the size of the pay envelope, but rather decrease it, especially with the brightest boys.

These curves are, of course, upset by the conditions of the past six years, and will also be upset by a person changing from one industry to another, as often the experienced man in a new job is not worth as much as the boy who has not so much to unlearn. The curves are merely intended as averages for average conditions.

A Machine Tool Shop of Unusual Construction

Three Monitor Houses Provide Excellent Crane Facilities—Saw-Tooth Interior Gives Excellent Lighting Facilities and Ventilation—An Unusual Shop

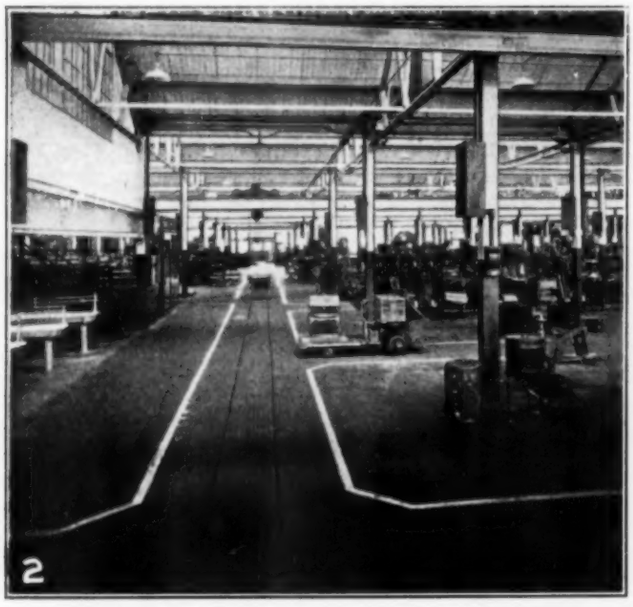
By FRED H. COLVIN
Editor, *American Machinist*



THE improvements which have taken place in machine shop construction can hardly be better exemplified than in the new plant of the Colburn Machine Tool Co., Ivanhoe Road, Cleveland, Ohio. Before deciding on the plans for the new shop, all the advantages and disadvantages of the former plant at Franklin, Pa., were carefully considered, in addition to making a very careful study of the best plants in various parts of the country. The result is a remarkably pleasing combination of saw-tooth and monitor construction. The whole plant shows extremely careful planning and the results will speak for themselves when the plans and the illustrations of the interior are considered.

The general construction of the shop is shown in the headpiece, the monitor roof section being in the form of a letter U while the saw-tooth portion is in the center. At the right-hand end is a shipping platform 282 ft. long with a spur track so that raw material can be received and finished product shipped as expeditiously and with as little handling cost as possible. The office, or administration building is in front of the middle of the long side of the shop, and connects directly with the center of the long erecting bay. Some idea of the lighting can be had, by noting the number of windows on each side, while the saw-tooth roof lights up the center of the shop in splendid fashion. This will be more convincingly shown in the illustrations of the interior. While no general interior view can give an adequate idea of such a shop as this, Fig. 2, taken from the front and looking along the center aisle toward the stockroom, gives some idea of the construction of the central or saw-tooth portion. This, coupled with Fig. 3, which shows the portion of the rear head-house, occupied by the stock bins for storing small parts, gives a good idea of the lighting obtained in the two sections of the shop.

Fig. 2 shows the spacing of the steel columns and one of the large cranes on its runway. The narrow track down the center aisle, enables transfer cars to be used so that material can be moved from one aisle to another, without being carried to the head house and handled by the large crane which serves it. It also runs through the stockroom and into the storage yard at the back. The flooring is of impregnated wooden blocks and aisle boundary marks are carefully maintained both to assist in the transportation of materials and to maintain a neat appearance by insuring orderly piling of castings and other material. There is a clearance of 15 ft. 8 in. to the bottom of the roof truss and



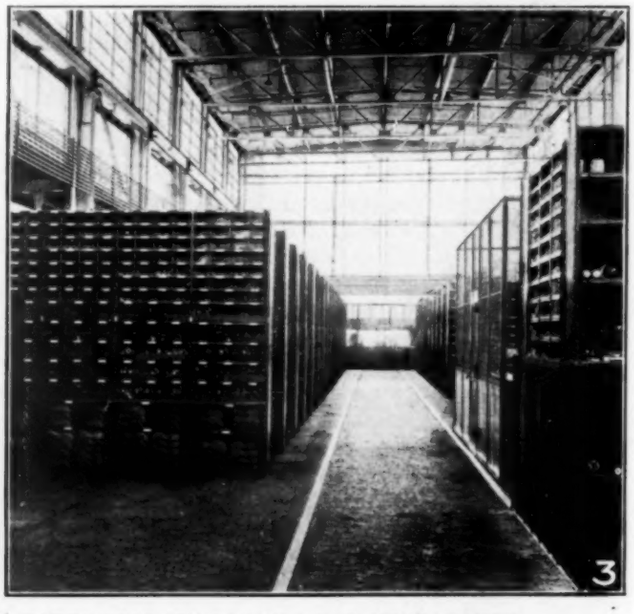


FIG. 2. DOWN THE CENTER AISLE. FIG. 3. THE PARTS STORAGE BIN IN REAR HEAD HOUSE

12 ft. in the clear to the bottom of the beams which form the crane runway.

Fig. 2 shows the washroom with toilet above, the shop motor crane just off the main aisle, a car on the center track, the electric terminals on the columns, and the general appearance of the central portion.

The floor plan of the present building is shown in Fig. 4 with each department noted and the crane service also given in each section of the shop. The construction of both the head houses and the saw-tooth section is shown in Fig. 5, the main dimensions are given and show every evidence of careful planning. The shipping

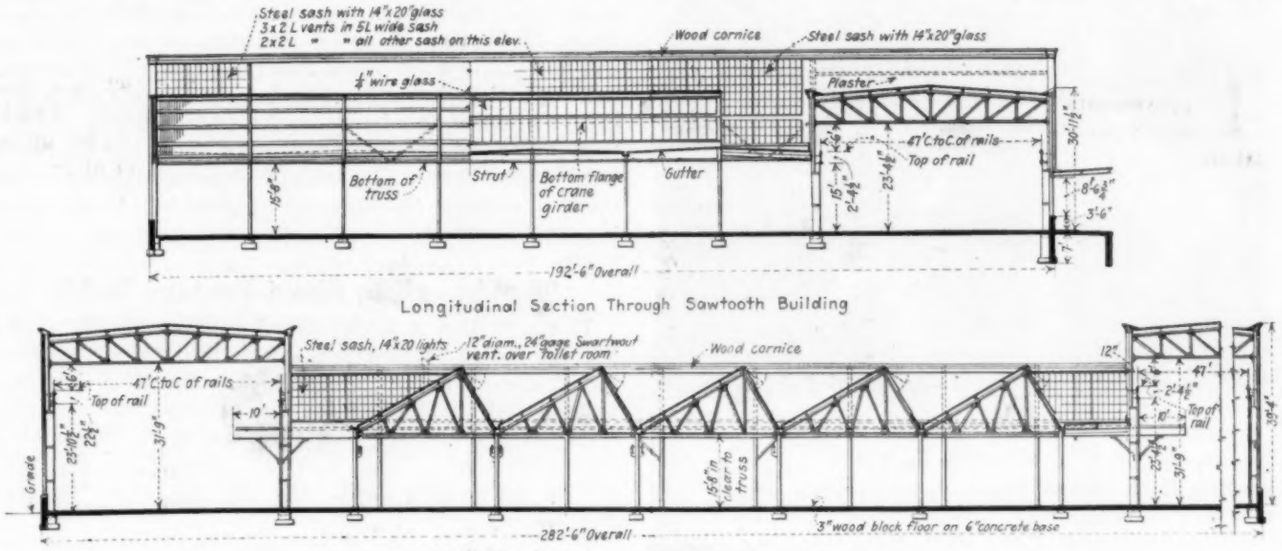

Steel sash with 14"x20" glass
3 x 2 L vents in 5 L wide sash
2 x 2 L " " all other sash on this elev.
Wood cornice
Steel sash with 14"x20" glass
¼" wire glass
Plaster
47' C. to C. of rails
Top of rail
Bottom of truss
Strut
Bottom flange of crane girder
Gutter
192'-6" Overall
Longitudinal Section Through Sawtooth Building
Steel sash, 14"x20" lights
12" diam., 26 gage Swartwout vent. over toilet room
Wood cornice
47' C. to C. of rails
Top of rail
10'
Grade
282'-6" Overall
3" wood block floor on 6" concrete base
Cross Section Through Sawtooth Building and Head Houses

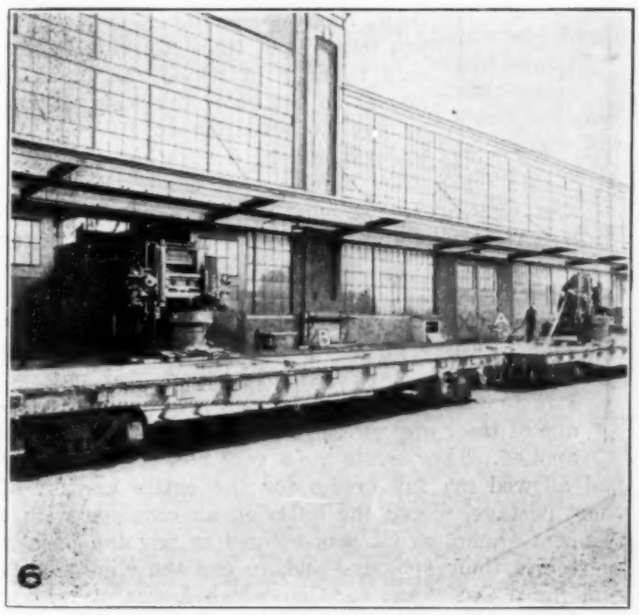
FIG. 5. SOME DETAILS OF THE BUILDING CONSTRUCTION

The head house shown in Fig. 4 is 31 ft. 9 in. to the bottom of the roof truss and 23 ft. 10½ in. to the bottom of the crane rail. The span is 47 ft. center to center of crane rail. The volume of light obtained in this monitor construction can be readily seen. The heating coils in both sections are overhead as can be seen in both Figs. 2 and 3.

The plot of ground allows for considerable expansion, in such a manner as to continue the same method of construction. The present shop building is 312 ft. front by 282 ft. deep. Future expansion will be in the direction of depth, so that what is now the rear head house will be a central bay with a saw-tooth roof section between this and the new head house at the rear.

platform at the end of the building extends the whole depth of the building and is 12 ft. wide.

A view of this is shown in Fig. 6 with two flat cars in position and shows the way in which large boring mills and other machine tools can be easily loaded. The winch at *A* is driven by an electric motor under the platform and by the use of snatch blocks and other tackle it is an easy matter to pull machine tools out of the shop and on to the cars with very few men. By simply moving the snatch block to various "eyes" which are provided for it, heavy material can be unloaded from the cars in the same way, or the cars themselves can be moved to any desired position easily and quickly. The cement road in front of the cars is for truck service



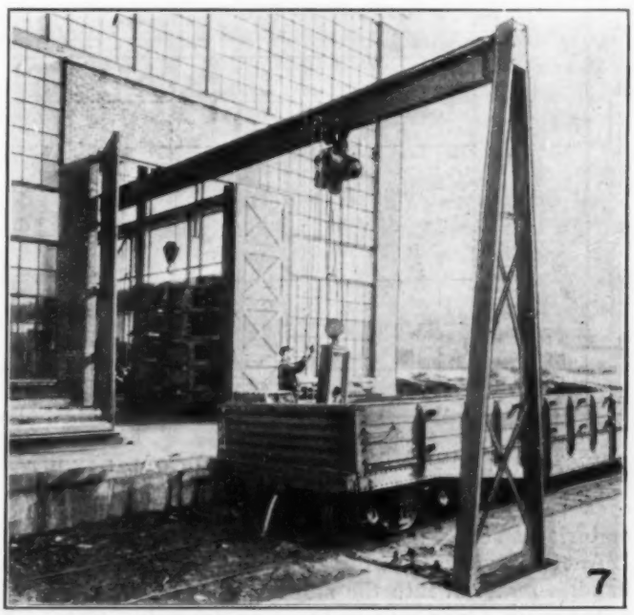


FIG. 6. HANDLING HEAVY MACHINES ON THE LOADING PLATFORM. FIG. 7. UNLOADING RAW MATERIAL FOR STOREROOM

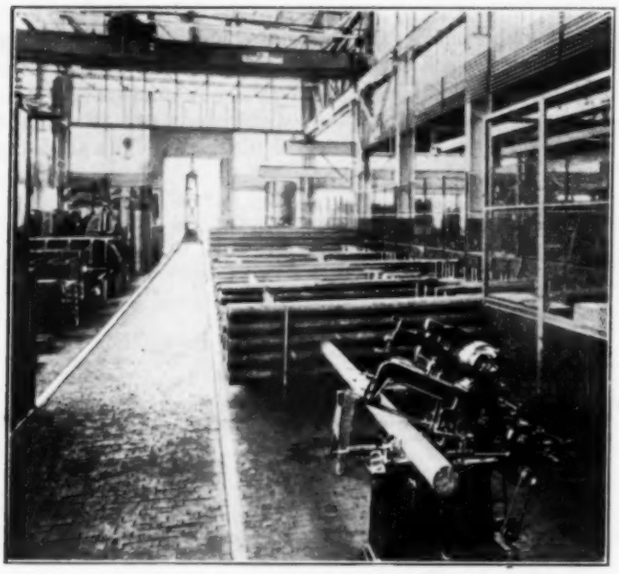


FIG. 8. THE BAR STOCK STORAGE

and the rack at *B* is for rollers used in moving machines, keeping them out of the way, but always within easy reach.

At the back end of the platform a traveling hoist is provided as shown in Fig. 7, for unloading material from the cars into the stockroom. This is of ample capacity for handling any material which may be necessary and provides a direct means of getting material into the shop through its proper channels. One of the eyes used in connection with the winch for moving material is shown at *A*.

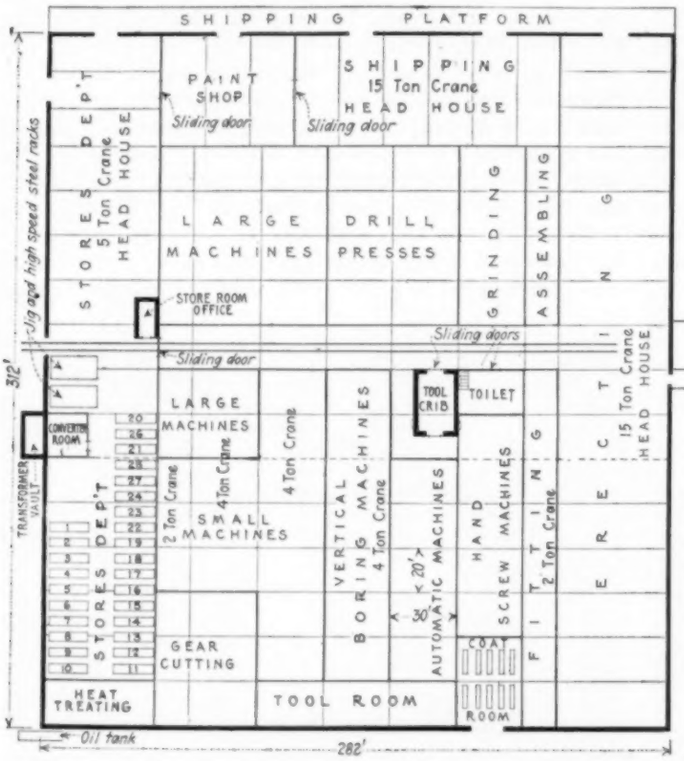


FIG. 4. FLOOR PLAN OF SHOP AND TOOL LAYOUT

Another view showing how this unloading crane handles material into the storage bay is shown in Fig. 8, the crane being seen in the open doorway. This also shows the arrangement of the bar stock on the right with the hacksaws for cutting it up located in a convenient position. On the left and also at the extreme right of the storage bay may be seen castings for drilling machines and boring mill bases, these being readily handled by the 5-ton Cleveland crane as soon as they are placed inside the storeroom door. This view also shows the extension of the crane runway from the head house beside the shipping platform so that material can be readily transferred from one crane to the other.

This article is confined mainly to the planning and construction of this building, the George S. Rider Company being the designing engineers, while the builder is the Hunkin, Conkey Co., both of Cleveland. Some of the other interesting features of this plant will be shown in the second article.

The American Short-Postage Habit

It seems like a petty question—that of the short-postage malady which prevails in the United States—but it doesn't appear to diminish. American business houses continue to slap the old two-cent stamp on all their letters and let them go. In some cases when their attention is called specially, they blame the office boy or the mailing clerk. It's nearly always "George" that does it.

E. B. Filsinger, export manager for Lawrence & Co., members of the American Manufacturers Export Association, recently received a letter from C. C. Woolward, American vice-consul at Cape Haitien, Hayti, on the subject of short-paid letters from the United States. (The Hayti case is in no degree isolated—Hayti simply is joining the chorus of nations.)

"I desire to call your attention to the question of short-paid postage," writes Mr. Woodward. "You cannot imagine the amount of adverse criticism and loss of business that results from the general practice of American firms in sending out trade circulars, advertising matter and letters with underpaid postage. The amount of penalty is double the amount of postage that is short. This is from six cents up. Six cents is not much, but 100 letters at six cents mean $6, and the trouble is that the merchant receives the 100 letters. When you remember that America is the only country in which the business houses do not know the postage rate, or pay no attention to it, you will understand the feeling of the merchants when they receive your mail. You must also remember that most of these merchants are not Americans and they do not hesitate to express their opinion publicly in the clubs, hotels and other places.

"A large department store in New York, with whom I carry on a deposit account, always sends me letters in envelopes with short-paid postage. I remonstrated with them, and sent them a package of their own envelopes with the penalty stamps applied. They wrote me a very nice letter in reply and allowed me full credit for the entire amount of short postage, placed the letter in an envelope with a two-cent stamp, and I was obliged to pay the penalty to receive their apology—and, to cap the climax, they sent me a Christmas card on which I was obliged to pay the penalty.—*The Review of the American Chamber of Commerce in France.*

Organization and Management of the Small Shop

VIII. Small Shop Office Work—Why Bookkeeping Is Essential—Classifications of Entries —Functions of the Commercial Agencies—Value of Credit

By E. W. LEACH

THE phrase "small shop office work," may suggest to you and to me widely varying types of activity with as great a difference between them as there is between black and white. To the writer, in his first year's experience as a small-shop owner, office work meant an evenings and Sundays proposition. There was too much work of other nature to be done during working hours to spend any of that time in the "office," and so the business was built, the market developed, the sales made, and the many details of office routine taken care of purely as a "side-line job." In my own personal instance, I am not sure that that was the wisest course; in fact, later troubles proved that if more attention had been given to the office end of the business, our sailing would have been smoother.

Mechanical men entering business are too often apt to discount the real importance of other phases of business practice besides actual shop work with which they are familiar. Unless their training has been unusually broad, they are almost certain to have a prejudice in favor of their own narrow line of experience. The old question always bobs up; which is more important, office work or shop work? And it reminds me of a debate I heard one time on the subject, "Which is the more useful to man, a piano or a cow?" The speakers were really serious in presenting their arguments, but after all had been said and done, the thing just about simmered down to the simple fact that they both have their proper place. And that's true of office work and shop work. In small shops, especially, one must be careful to see that the office work is not sidetracked and neglected. There is something more to a manufacturing business than merely making things. Your customers do not judge your company entirely by the article they buy of you. Their opinion of your company and the prestige you enjoy with them depends also upon the businesslike way in which the several details incidental to their transactions with you are handled.

Possibly the first part of office work to receive the attention of the small-shop manager is "keeping books." I shall not attempt here to give an outline on how to open and keep a set of books, for it would be impossible to touch even the high spots of such a subject in an article of this length. I shall leave that to other writers, but I shall try to give some information about keeping books that will make the general nature of that job much more easily understood.

For your own good, do not be content with anything but a real, honest-to-goodness set of double-entry accounts. Double-entry bookkeeping holds a bug-bear for some people much like higher mathematics; but it is no more terrifying to the man who understands it than cutting sixteen threads to the inch is to an old-time lathe operator. Unless you are an experienced accountant, you should have someone open your set of books and start them off. In double-entry bookkeeping, your books are "opened" by preparing a statement of the condition of your business. This will show your assets and your liabilities; that is, it will show what you have and what you owe. In actual fact, however, some items will be included under liabilities that are not in the same class as your notes or contracts or accounts payable.

Cash invested and capital stock issued, for example, are listed as liabilities. It can be considered from one standpoint that the company owes you for the money you invest in the company, although it is understood that that money is not to be paid back to you as a loan to the company would be paid. Such investment is made a liability purely so that the opening statement will be "in balance"; that is, so that the total assets and liabilities will be the same.

The preparation of this statement and the determination of the several accounts into which various items shall be charged is an important bit of work, and should be done right by a competent person. After the books have been opened, it is not such a difficult job to keep them going by making the entries, and that is something you should be able to do yourself, if you do not plan to have other persons in the office. This statement starts your books out in balance. Entries that you make later as each transaction comes up are merely additions to this statement to keep it always up to date. For example, you might have an item "Equipment" in your original statement at $1,000, meaning you had that much equipment when you started out. If you bought a drill press for $200 later on, you would enter that amount and charge it to equipment, so that your equipment account would then show a total of $1,200. Your cash account would be brought up to date by being $200 less; or, if you did not pay cash for the machine, you would have accounts payable of $200.

"Double entry" means that each figure is always entered twice—once in the debit or left-hand column of some account, and again in the credit or right-hand column of some other account. This keeps the books always balanced, and makes it easy to prepare what is called a "Trial Balance." A trial balance "proves" your books; that is, it shows whether they really are correctly balanced.

From one standpoint, all book entries can be divided into two classifications, those involving cash and those not involving cash. Cash, from the bookkeeper's point of view, is of two kinds, cash received and cash paid out; or, as he would put it, debit cash and credit cash. Debit cash, or cash received, is usually listed each day in a cash book. Credit cash, or cash paid out is recorded on the stubs in your check book. A journal is strictly a book in which those transactions not involving cash are entered from day to day. Oft-times, however, the journal and the cash book will be combined into one.

All items are listed in the journal each day as they occur. Then at any convenient time these items are transferred by copying or "posting" them into the ledger. In the ledger items are sorted out according to the several accounts. Items in the cash book and the check book are also posted into the ledger. In small-

shop practice, one ledger will at first serve all purposes. After the volume of business increases considerably, you will probably have three different ledgers—a sales ledger, in which are kept your various customers' accounts or accounts receivable; a purchase ledger, in which are kept accounts of the companies to whom you owe money or your accounts payable; and a general ledger, in which are kept such accounts as taxes, interest, dividends, rent, and such items.

Where a combined cash book and journal is used, all items are first entered in this book, both those that do and do not involve cash. Debit cash is credited in another column on the same page by listing it under accounts receivable or whatever account it should be credited to. Credit cash is entered by listing the persons or companies to whom the checks are made out, showing the amounts of the checks under credit cash, and debiting the proper account to which this check should be charged. On such a page, there are usually six to ten columns for the most common ledger accounts, such as payroll, merchandise purchases, office expense, advertising, heat, light and power. Taxes and other similar accounts are not used so often, so checks made out for such purposes are debited to a column listed "General Ledger."

Copies of the invoices sent out to your customers should be kept in some sort of binder. The amounts on these invoices are posted directly to the proper individual accounts receivable. I know of one company rated at more than half a million dollars that keeps no purchase ledger. Invoices as they are received in the mail are sorted out and those from each firm are kept together. When the monthly statement arrives it is pinned to the invoices and put through for payment.

Each month you should take a trial balance of your accounts. A trial balance is merely a listing of the balances of your various ledger accounts. It shows that your book entries are correct; but in itself, it indicates nothing about the financial condition of your business. A comparison of trial balances for several months can show certain things to suggest whether you are gaining or losing ground. For example, it will show whether certain expenses are increasing out of proportion to sales. Most information that you will use as an index to your financial situation must be had by preparing special statements according to your own particular preference.

Financial Statements

The most common form of financial statement is a statement of assets and liabilities. This shows the net worth of the business, and a comparison of such statements from month to month can provide valuable information. One common special statement is one that shows your accounts receivable. It is made out each month at the time the statements are made out and mailed and it lists the balances shown on the individual monthly statements. You know the credit limits of your customers, and this statement will tell you if any of them are getting beyond a reasonable and safe amount.

Another detail that you should watch carefully is past due accounts. A statement each month at least (and oftener if conveniently possible) should be made up showing the total accounts receivable, the amount 30 days past due, the amount 60 days past due, and the amount 90 days past due.

The ratio of merchandise purchases to sales is important. If your product remains fairly uniform, there should be but little variation to this ratio. If it becomes much larger than usual, it means that you have bought more than was necessary in that month, and that during the next month you should make an effort to hold your purchases down.

After you have several men on the weekly payroll, the ratio of indirect labor to direct labor will be important. This ratio tells whether your "non-productive" labor is increasing, and of course that is an item of expense that you want to keep down as small as possible.

Whole volumes have been written on the uses of the steel square, and yet some carpenters use one only as they would a foot rule. So it is with your books. If they mean to you merely a necessary evil that has been handed down to present business men from past practice, you are overlooking a big opportunity for a real insight into and a real study of the activities of your shop. Your books can tell you a lot of things if you will only let them. They can tell you if you are making good or if you are going to the bad. They can show you the leaks that are eating into your profits. One businessman said that the average manager has not so much to fear from outside competition as from inside bungling. Clean-cut, informative statements taken from your accounts will not only show where the leaks are occurring, but they will indicate where leaks are likely to occur, and will forewarn you in time so that you may take steps to prevent errors and losses.

The Commercial Agencies

Shortly after you have opened your shop, you will be asked to furnish financial statements showing the worth of your business to the commercial agencies, Dun and Bradstreet. It is hard to conceive so foolish a viewpoint, but some small shop owners reply to such a request, "Why, it's nobody's business how much we are worth." If they could but realize how they are only hurting themselves by so doing, they would never follow so shortsighted a policy. By all means co-operate with the agencies by furnishing this information. One of your biggest jobs during the first year will be for you to establish a credit. The business of the world is done on credit. When companies extend you credit, that is when they permit you to purchase goods from them without insisting that you pay cash, it simply means that they trust you, that they have confidence in your good faith and your business integrity.

Concerns do not extend credit by guesswork. They must have information of some sort to show that they are actually justified in believing that you will pay your debts when they are due. The books of the commercial agencies furnish such information. Dun and Bradstreet publish books four times a year, listing every business concern in the country whose name they can obtain. This listing also shows the kind of business in which that company is engaged.

The important part of the listing, however, is the estimated worth and the grade of credit. The estimated worth is the portion of the worth of your business as shown on your financial statement that they believe should be taken into consideration by companies who are considering extending you discounts and terms. I express it in that way for a very good reason. If you turned in a statement listing plant and equipment

at $5,000, accounts receivable at $3,000, and patents and good-will at $67,000, you must not expect to have your net worth listed at $75,000. You'll understand why, if we assume that such a statement were accepted in full and you were given a $75,000 rating. Suppose some jobber extended you credit on that basis, and permitted you to make purchases totaling $20,000. Suppose further that your product proved unmarketable, and your company was declared insolvent. You could turn your plant and equipment into cash and you could collect your accounts receivable, but your patents and good-will would not be worth a cent. That would leave $12,000 on that account that you could meet from the real assets of your business. The point is that padding a financial statement never accomplishes any good, and it is a practice that seldom "gets by." However, at intervals when there may have been increases in your net worth that will affect your rating, you should surely send a statement in to the agencies so that they will have the most recent information about your condition.

Establishing a Credit Rating

Your grade of credit is listed in Bradstreet's as good, fair or undetermined; in Dun's as first, second, third or fourth. It is based upon your performance in meeting obligations promptly when due, upon the general nature and conduct of your business, and upon the character and past experiences of the members of your company. Just incidentally, that throws out the suggestion of another reason why you should be careful in choosing your business associates. If one of your partners has a record of having been a failure in other business ventures, his personal record will have a limiting effect on your credit standing.

Those concerns who use the service of the commercial agencies not only receive these books each three months, but they are also entitled to call for a certain number of special reports on particular firms. These reports show complete financial statements, they outline the history of the firm, they tell if the company has ever been insolvent or suffered loss by fire, they say a word about each member of the company, and they sometimes give remarks and opinions about the credit standing of the company, quoting from people with whom that company has accounts.

Remember that these agencies are purely impartial. They hold no interest in your company nor in your competitors. They are not especially interested in writing a report that will be unusually complimentary or derogatory. They are only concerned in presenting the actual facts as they believe them to be. Of course you want a good rating, and you want to know that the report on your business is one that will inspire other business men to have confidence in you.

That good rating and that good report are entirely under your own control. You can have them and enjoy the benefits that follow as a natural result if you are able to furnish the sort of financial statement that indicates a healthy growing business, a business conducted on sound principles and policies, and by men of character who play the game with both hands above board and all cards on the table.

Industrial Administration in Manchester "Tech," England

The Municipal College of Technology, Manchester, England, has recently opened a "Department of Industrial Administration," with the following objectives, to use the words of authorities of the college: (1) To investigate all problems relating to industrial management and to collect and co-ordinate the information obtained, with a view to assisting in the building up of a science of industrial administration; (2) to put all knowledge so gained at the disposal of the business community, and in particular to organize classes and lectures for managers, workers and students.

The subjects to be studied in the Department will be as follows:

Industrial History: Mediaeval Guilds (statute of apprentices, domestic system, colonial expansion); Industrial Revolution (mechanical inventions and improvements in transportation); Factory Legislation (trade unions and employers' associations, co-operative movement, health insurance, unemployment insurances).

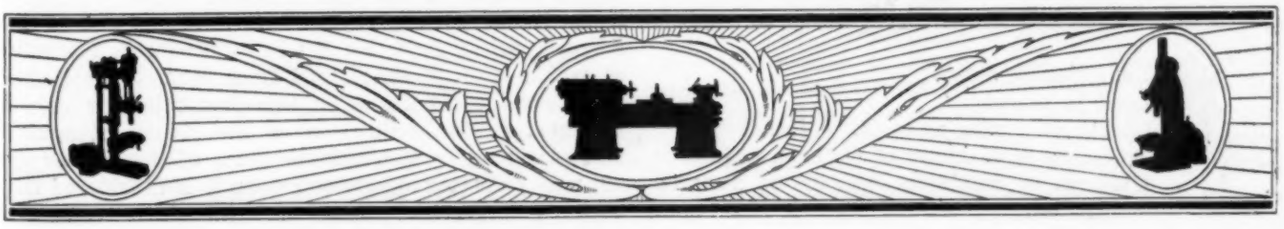
Labor Aspirations: Trade unions (conciliation and arbitration, national industrial councils, trade boards); State Socialism: (Guild Socialism, syndicalism, communism and bolshevism.)

Economics: General principles (production, labor and machinery, unemployment, exchange, credit and interest, distribution); Organization of Industry and Commerce (competition, localization, combinations, company formation, foreign trade); Industrial Finance (gold and paper money, inflation, index numbers, banking, company funds, foreign exchange).

Technique of Management: Types of management (departmental, functional, committee); Employment (selection, education, training, discipline, works regulations); Routine (planning, progressing, graphical and statistical control, cost accounting, time and general offices); Experimental (progressing, rate fixing, time and motion study, fatigue).

Personal: Incentives (time, pieces, premium plans, sliding scale, profit-sharing, co-partnership, promotion); Working Conditions (security of tenure, sick benefits, pensions, holidays, safety and first aid, hygiene and sanitation, welfare, canteens, etc.); Inter-relations (Internal publicity, personal contact, community interests, works' committees, spheres of activity, relation to management); Education (continuation education, apprenticeship schemes, general adult and vocational training); Recreation (cultural, sports, handicrafts).

Taking into account the general interest in industrial management, which is felt now both in this country and in Europe, one cannot fail to notice that the new department of Manchester College meets this interest with a very complete program.



The Design of Springs

Control of the "Spring Criterion"—Formulas for Leaf Springs Constrained at One or Both Ends—Characteristics of Coil, Spiral and Buffer Springs

BY JOSEPH KAYE WOOD
Engineer, Western Electric Co., Inc., A. T. & T. Co.

IN THE previous article by the author on page 46 of the *American Machinist*, two general formulas for single flat springs were derived from the fundamental equations for the flexural deflection and strength of a beam. The two formulas referred to are:

$$\text{Deflection } F = \frac{\psi P l^3}{E b_m d^3} \qquad (1)$$

$$\text{Spring Criterion } \frac{Fd}{l^2} < \phi \frac{S}{E} \text{ Material Index} \qquad (2)$$

where ψ and ϕ are constants depending upon the form of the spring. Or, as the thickness d is necessarily kept constant for commercial reasons, the constants depend directly upon the relation between the principal breadths b_e and b_m of the spring. For similar "economical" spring forms which give nearly uniform distribution of stress, the values of ψ and ϕ are four times greater in the case where only one end of the spring is constrained than in the case where the two ends are constrained. To constrain the loaded end of a flat spring means to keep the plane of the flat part which is clamped or imbedded parallel to the plane of the other stationary and imbedded flat part while the spring is being deflected. If these two parts are not parallel, then the corresponding ratios of the values of ψ and ϕ will be greater or less than four, according to the angle which the planes of these two parts make with each other. The value of ψ may be determined from the following expression:

$$\psi_1 = \frac{12\, b_m}{b_e + 2\, b_m} \text{ for one constrained end;}$$

and, $\psi_2 = \frac{\psi_1}{4}$ for two constrained ends.

The value of ϕ may likewise be determined from:

$$\phi_1 = \frac{\psi_1}{6} \text{ for one constrained end;}$$

and, $\phi_2 = \frac{\psi_2}{6}$ for two constrained ends.

In this article it will be shown that all springs of the flexural type, that is, all springs which are deflected by a bending moment, may be designed by formulas of the same general form as formulas (1) and (2). Hence, the expressions for ψ and ϕ will now be derived for the following springs:

(a) Leaf spring with one constrained end,
(b) Leaf spring with two constrained ends,
(c) Coiled spring,
(d) Spiral spring,
(e) Buffer spring.

In considering these springs the same symbols employed in previous articles will be used, these symbols being:

F = Deflection in inches;
P = Load in pounds;
l = Length of spring material in inches;
d = Thickness or diameter of material in inches;
b_m = Uniform or maximum breadth of material in inches;
b_e = Minimum breadth of material in inches;
S = Maximum safe fiber stress in pounds per square inch;
E = Modulus of elasticity in pounds per square inch;
n = Number of spring units.
ψ and ϕ were previously described.

(a) Leaf Spring with One Constrained End:

We have previously shown that the formula for the deflection of a triangular-shaped spring is

$$F = \frac{6\, P l^3}{E b_m d^3} \qquad (3)$$

Now, if a certain triangular-shaped spring has a breadth B equal to some whole number, say n, times

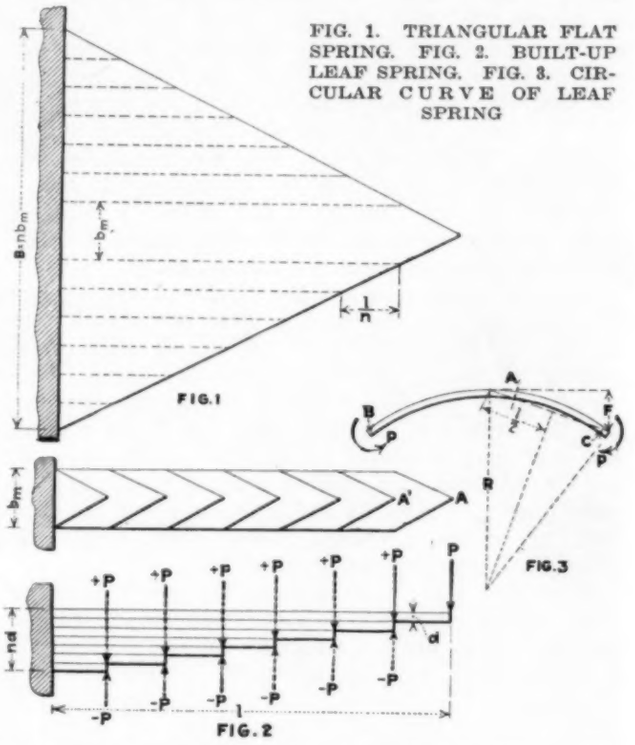


FIG. 1. TRIANGULAR FLAT SPRING. FIG. 2. BUILT-UP LEAF SPRING. FIG. 3. CIRCULAR CURVE OF LEAF SPRING

b_m in the formula, then the formula for this spring may be written as follows:

$$F = \frac{6\, P l^3}{E B d^3} = \frac{6\, P l^3}{E n b_m d^3} \qquad (4)$$

In Fig. 1 the base of the triangle has been divided into $2n$ equal parts and perpendiculars erected at each point of the division. By super-imposing the parts on top of each other the spring pile-up shown in Fig. 2 is produced. In applying a load P at the end of the longest part, a deflection F will be produced, the value of which may be determined from formula (4). The fact that the deflections of this composite spring will be equal to the deflections of the single triangular-shaped spring from which the parts of the former are cut may be better understood when it is considered that each small particle of the material of the composite

spring has the same external moment, is the same distance from the neutral plane and has the same approximate curvature as it would have as a single triangular-shaped spring. However, a more rigorous proof of this fact will now be given. The fundamental equation of the elastic curve is as follows:

$$R = \frac{EI}{M} \tag{5}$$

in which R is the radius of curvature, I the moment in inertia of a normal section and M the applied moment. If the rate of change of direction of the neutral plane is uniform, then the curve is circular. As shown in the previous article, the curve of the neutral plane of a deflected triangular-shaped spring changes uniformly in direction because every particle in its length is distorted an equal amount. Hence the resulting curve must be circular. Now, if a certain length of flat material is acted upon at both ends by equal and opposite couples, as shown in Fig. 3, the resulting curve of the neutral plane will be circular also, because all particles are bent an equal amount. This may better be seen by taking any point A and considering the forces necessary to maintain equilibrium. At section A the part AB will exert a couple on part AC equal and opposite to the couple at C, and the part AC will exert an equal and opposite couple on the part AB, and likewise for any other section considered. Consequently, this proves that the entire spring is bent uniformly into the arc of a circle. So much for the single triangular-shaped spring.

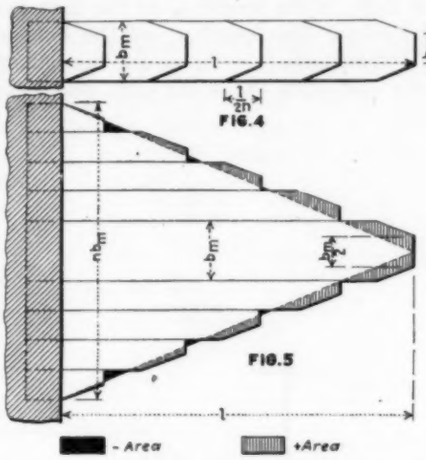


FIG. 4. APEXES OF LEAVES REMOVED.
FIG. 5. SINGLE LEAF EQUIVALENT TO SPRING IN FIG. 4

Now, referring again to Fig. 2, the load P bends the triangular portion AA' of the lowest unit into the arc of the circle whose radius is

$$R = \frac{EI}{M} = \frac{Eb_m d^3}{12\,Pl/n} \tag{6}$$

The end of the rectangular portion at A', which is on the circular arc, will exert a pressure P against the apex of the triangular portion of the next spring unit, because at any section in the same arc the bending force is the same. This in turn will bend the portion $A'A''$ into the arc of a circle whose radius is equal to that above, and so on for the entire spring. Thus we have all upward pressures exerted on the outer ends of the rectangular portions equal and opposite to all except one of the downward pressures exerted on the apexes of the triangular portions. Consequently, we have exactly the same conditions as with a single triangular spring having a base equal to nb_m and a length equal to $n\frac{l}{n} = l$ and a radius of curvature equal to

$$R = \frac{EI}{M} = \frac{Enb_m d^3}{12\,Pl} \tag{7}$$

due to a load P applied at the apex. Formula (7) is identical with formula (6), which is the radius of curvature for all the spring units of the composite spring.

The expression for the deflection F in terms of the radius R is derived as follows:

Referring to Fig. 3, it is found from similar triangles that $F:l = l/2:R$, which gives

$$F = \frac{l^2}{2\,R} \tag{8}$$

From formulas (8) and (7) we get

$$F = \frac{6\,Pl^3}{Enb_m d^3} \tag{9}$$

which is identical with and proves formula (4). This then is the formula for the deflection of a leaf spring having one constrained end. Instead of making the ends of the spring units triangular in shape, the thickness toward the end may be made parabolic in order to secure uniform bending. This spring is also covered by formula (9). However, shaping the material in this way would not be commercial, except in the case of large springs such as are used in automobiles.

In the automobile industry the matter of so-called elliptical springs, which are double-leaf springs, has been made the subject of extensive investigation in which the clamping of the leaf units together, the initial distance between the leaf units before clamping, and the coefficient of friction between the leaf units enters largely into the calculations of their dimensions.

In practice, the apexes of the leaf units are cut off, as shown in Fig. 4. However, formula (9) is used for this spring, the approximation being in error by about 5 per cent or less where the number of spring units is greater than four. The extent of the approximation is shown graphically in Fig. 5.

(b) Leaf Spring with Two Constrained Ends:

In a previous article by the author it was shown that an economical spring or a spring having nearly uniform bending and constrained at both ends should have the shape shown in Fig. 6. This spring can be considered as consisting of two springs of length $l/2$, each deflected an equal amount but in opposite directions. In order to economize in space we may make each half section a leaf spring with the pile-ups of leaf units on opposite sides, as shown in Fig. 7. We may do this because we have shown that the deflection of the leaf spring would be equal to that of the single spring from which it is made, for the same load P. This spring may then be designed by the formula used for a single unit of this type of spring where the breath b_m is

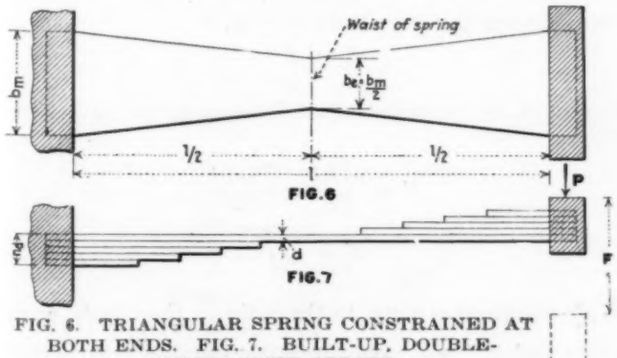


FIG. 6. TRIANGULAR SPRING CONSTRAINED AT BOTH ENDS. FIG. 7. BUILT-UP, DOUBLE-CONSTRAINED SPRING

equal to n times the breath b_m of the leaf spring. The formula may then be written as follows:

$$F = \frac{2 \times 6\,P}{Enb_m d^3} \times \left(\frac{l}{2}\right)^3 = \frac{3\,Pl^3}{2\,Enb_m d^3} \qquad (10)$$

This is the formula for deflections of leaf springs having two constrained ends.

SPRING CRITERION FOR SPRINGS (*a*) AND (*b*)

The flexural strength of the leaf springs covered in (*a*) and (*b*), which may be easily derived in the regular manner is as follows:

$$S = \frac{6\,Pl}{nb_m d^2} \qquad (11)$$

By equating the allowable maximum work to the resilience as outlined in the previous article, or doing that which is a short-cut and substituting P in formulas (11) and (9) respectively, we get

$$\textit{Spring Criterion } \frac{Fd}{l^2} = \phi \frac{S}{E} \textit{ Material Index}$$

Where $\phi = 1$ for the leaf spring having one constrained end,

and $\phi = \frac{1}{4}$ for the leaf spring having two constrained ends.

(c) Coiled Spring:

In Fig. 8 is shown a single coil bent and "set" in the form of a circle whose radius is R. By applying a force P at the end A, while keeping the other end C stationary, which constitutes two equal and opposite couples, so that the elastic limit of the material is not exceeded, the circular coil is bent into a smaller circular coil of radius R_o. In the discussion on the previous types of springs it was brought out that if the loads are applied in such a way when bending a material as to make the neutral plane circular, the bending will be uniform throughout the entire length, or in the case of uniform cross-section the bending moment will be constant. Hence, we may consider the effect of the lever distance D shown in the sketch as simply increasing the couple applied; as, for example, if the load be P then the couple applied will be twice as great if the lever distance D is made 4 in. instead of 2 in. In the diagram, the point of application of the load P travels in the circumference of a circle whose radius is equal to the lever distance D and the ends are not constrained, the latter condition being sometimes only approximated in practice. However, in any case, the approximation of this condition will not cause any appreciable error in the calculation of the spring's dimensions.

From equation (5) of the elastic curve

$$\frac{1}{R} = \frac{M}{EI}$$

the relation between $\frac{1}{R}$ and M may be shown by a straight line curve as in Fig. 9, where oc is the initial curvature of the coil $\frac{1}{R_o}$ before being deflected by a moment M_p. The moment necessary to produce the initial curvature $\frac{1}{R_o}$, which may be designated as M_o, is equal to $\frac{EI}{R_o}$. Therefore the curvature $\frac{1}{R_p}$ produced by a moment M_p may be written as follows

$$\frac{1}{R_p} = \frac{M_p + M_o}{EI} \qquad (11)$$

Substituting the value of $M_o = \frac{EI}{R_o}$ in this equation gives

$$\frac{1}{R_p} = \frac{M_p + \frac{EI}{R_o}}{EI} = \frac{M_p R_o + EI}{EIR_o}$$

or, $$R_o EI = M_p R_p R_o + R_p EI$$

Multiplying this by 2π gives

$$(2\pi R_o)EI = (2\pi R_o)M_p R_p + (2\pi R_p)EI$$

Now $2\pi R_o$ is the length l_o of the loop before deflection, and $2\pi R_p$ is the length l_p of the loop after deflection.

Furthermore, $l_o - l_p = F_r$, the deflection or overlap of one end upon the other end, which for n coils would

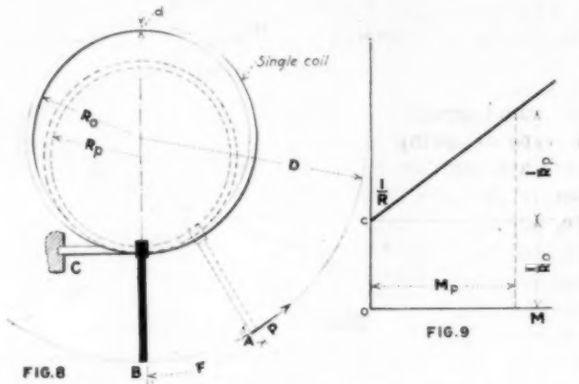


FIG. 8. ACTION OF SINGLE-COIL SPRING. FIG. 9. RELATION BETWEEN CURVATURE AND MOVEMENT

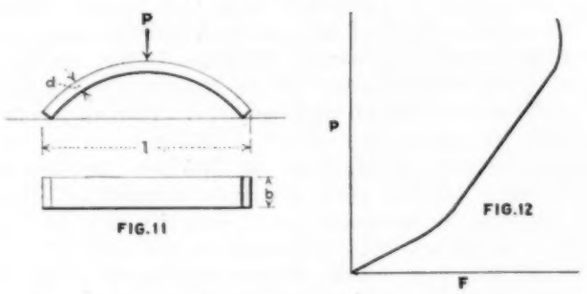


FIG. 11. BUFFER SPRING. FIG. 12. PRESSURE-DEFLECTION CURVE FOR BUFFER SPRING

be equal to nF_r. Only one coil, however, is being considered now. Therefore, the last expression becomes

$$F_r EI = l_o M_p R_p$$

Or, transposing, we get

$$\frac{F_r}{R_p} = \frac{M_p l_o}{EI}$$

From similar sectors, shown in Fig. 8,

$$\frac{F_r}{R_p} = \frac{F}{D}$$

Therefore, by substituting and dropping all subscripts we get

$$F = \frac{MDl}{EI} = \frac{PDDl}{EI}$$

Or, $$F = \frac{PD^2 l}{EI} \qquad (12)$$

If we designate ω equal to the ratio $\frac{R}{D}$, then l will equal $2\pi D\omega$ and if there are n coils the total F will be "n"

times greater. I equal $\frac{bd^3}{12}$

Hence, we have

$$F = (24\pi n\omega)\frac{PD^2}{Ebd^3} = \psi\frac{PD^2}{Ebd^3} \qquad (13)$$

as the general formula for coiled springs in flexure. It must be remembered in connection with this formula that the deflection F is measured in length units in the arc of a circle whose radius is equal to the lever distance D. Here $(24\pi n\omega)$ equals ψ.

(d) Spiral Spring:

A considerably greater amount of resilient energy in a given space may be obtained from the spiral type of spring than from the coiled type, for which reason they are chosen as storage "tanks" for the necessary energy to run a clock or similar mechanism 24 hours or more continuously.

The principles upon which the formula for this type of spring is based are similar to those of the coiled type, and the formula may be derived in the same manner. Both formulas, however, may be derived in a slightly different manner, which will now be demonstrated in deriving the formula for spiral springs. A certain length l of material is formed into a spiral and "set," as shown in Fig. 10. The application of a bending moment M, which may be called a multiplied couple, will change the radius of curvature of each 360 deg. of the neutral plane an equal amount; or, in other words, will change the rate of change of direction γ, which is approximately constant for the entire length. Hence, we may write

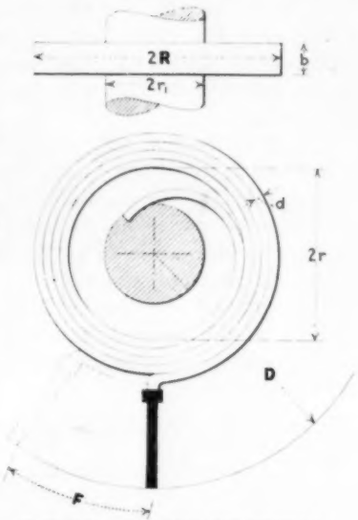


FIG. 10. ACTION OF SPIRAL SPRING

$$M = \frac{EI}{R} = EI\gamma = Constant \qquad (14)$$

Now let β equal the total change in rate of change in direction or angular distorsion and $\gamma\delta l$ the angular distortion for each element δl. Then we have

$$M\delta l = EI\lambda\delta l = EI\delta\beta$$

By integration,

$$Ml = EI\beta$$

or,

$$\beta = \frac{Ml}{EI}$$

Now,

$$\beta = \frac{F}{D}$$

$$\therefore F = \frac{M\,D\,l}{EI} \qquad (15)$$

which gives precisely the same formula as for the coiled spring. Substituting, since

$$l = 2\pi\frac{(R+r)}{2}\,n \text{ approximately,}$$

$$M = PD, \text{ and } I = \frac{bd^3}{12},$$

we get

$$F = \frac{12\pi nPD^2(R+r)}{Ebd^3} \qquad (16)$$

Furthermore, let $m = \frac{r}{R}$, and $\omega = \frac{R}{D}$

Substituting gives

$$F = (12\pi n\omega m)\frac{PD^3}{Ebd^3} \qquad (17)$$

as the general formula for a spiral spring where the deflections F are measured on the arc of a circle whose radius equals D. Here $(12\pi n\omega m)$ equals ψ.

Round Section for Cases (c) and (d):

Where material of round cross-section is used, for case (c) with coiled springs change b to d and multiply ψ by $\frac{16}{3\pi}$, and for case (d) with spiral springs change b to d and multiply ψ by $\frac{32}{3\pi}$.

Flexure Formula for Cases (c) and (d):

As the bending moment is the same at any point in these springs, the weakest section is also liable to be at any point. But the flexure formula for both cases is derived in precisely the same manner as for all other types of springs in flxure. Hence, the formulas are given below in their final form. For cases (c) and (d):

$$P = \frac{Sbd^2}{6D} \text{ for flat section;}$$

and,

$$P = \frac{Sdd^2}{32D} \text{ for round section}$$

Spring Criterion for Cases (c) and (d):

Using precisely the same method as in deriving the spring criterion for other spring forms the following relations are derived:

$$\textit{Spring Criterion } \frac{Fd}{D^2} < \phi\frac{S}{E} \textit{ Material Index,}$$

For (c) Coiled Spring,

$$\phi \text{ equals } \frac{\psi}{6} = 4\pi n\omega \text{ for flat section;}$$

and,

$$\phi \text{ equals } \frac{\pi}{32}\psi = 4\pi n\omega \text{ for round section.}$$

For (d) Spiral Spring,

$$\phi \text{ equals } \frac{\psi}{6} = 2\pi n\omega m \text{ for flat section;}$$

and,

$$\phi \text{ equals } \frac{\pi}{32}\psi = 4\pi n\omega m \text{ for round section;}$$

(e) Buffer Spring:

This spring is simply a curved flat piece of material with the load P applied in the center as shown in Fig. 11. The formula is that of the simple beam, namely

$$F = \frac{Pl^3}{4Ebd^3}$$

and *Spring Criterion* $\frac{Fd}{l^2} < \phi\frac{S}{E}$ *Material Index*

where

$$\phi = \frac{l}{6}$$

However, where b is considerably larger than l it complicates the formula of this particular type of spring. The pressure-deflection curve of such a spring is shown in Fig. 12. This special case will be covered in a special article.

The next article will be a summation of the design of all types of springs covered in this series of spring articles, including a universal spring chart for springs in flexure and some very useful constants covering various spring materials. The use of the chart ought to greatly simplify and reduce the laborious calculation work in spring design.

Making the Coventry Self-Opening Diehead

Materials Tested in an Up-to-date Laboratory—Parts Inspected and Sent to Storeroom for Re-issue After Each Operation—Accurate Broaching

SPECIAL CORRESPONDENCE

THE manufacture of the Coventry dieheads by Alfred Herbert, Ltd., is carried out in a self-contained factory at Edgwick on the outskirts of Coventry, England. The shops are of the latest single-story construction, the personnel being housed under the best workshop conditions, and the equipment specially installed for dealing with this particular product. A large and modern laboratory for carrying out chemical and physical tests has just been erected, superseding the original building. Here all the raw material entering into the construction of the dieheads is subjected to the necessary tests. Neither time nor expense is spared to carry out the most rigorous tests on raw material prior to entering the shops. After analysis under the personal supervision of the chief chemist, the material is subjected to special heat-treatment, so as to insure the maintenance of uniform quality throughout.

After heat-treatment the forgings are tested for hardness by the Brinell method, special apparatus being employed. Fig. 1 shows some diehead forgings being tested. The mechanism on the wall immediately above the machine provides a means for rendering the efficiency of the test independent of the operator. By special adaptation the load is always applied at the same rate and automatically maintained for the same length of time. The forgings or other raw material having passed a stringent inspection test are now neatly stacked in the stores to be later issued against shop orders. An electric truck service conveys the material from the stores to the required spot, where it is again stacked so that the shops may be kept in spick-and-span order.

Fig. 2 shows the diehead complete while Fig. 3 shows the body which carries the dies and in which they fit directly without the intervention of carriers or shoes. The first operations are rough- and finish-turning for grinding, drilling and chamfering. The body is next supported on an arbor between centers on a universal grinding machine. The keyseating operation follows, and is performed on a duplex keyseating machine; keys are next fitted into the shank, and the work is located in relation to these keys for all subsequent operations. The body is then taken to a horizontal milling machine for milling the die slots. Fig. 4 depicts this operation. There are two milling operations at this stage, roughing and finishing. The fixture is designed for accurate indexing in four positions. The finest limits of accuracy are called both for width and location of slots and to insure this the slots are finally finished on a broaching machine, the body being held in a special fixture, as shown by Fig. 5.

Drilling the four holes for the front plate screws is the next operation, and then the front face of the body is surface ground. The fixture will hold twenty-five bodies at a time, the bodies being accurately located on studs. The fixture is placed on the magnetic chuck of the grinding machine and is of ample dimensions to preclude any possibility of distortion. After every operation a rigid inspection takes place, and in each case the finished part goes into stores for re-issue, so that the Progress Department may keep correct track of all work in progress.

In Fig. 6 is shown the external scroll which fits over the body. Its function is to close the dies and to take their end pressure when working. The external scroll is machined from a steel blank cut from the bar. The first operation is the roughing out of the shoulder to provide a true grip for the subsequent machining operations also the rear face is turned, rough drilled and chamfered. The next machining operation is putting in the annular recess at the back which takes the opening springs.

The next is a milling operation. The scrolls which locate the ends of the dies are milled on a Herbert No. 3 vertical milling machine in a special four-position indexing fixture. The fixture is offset from the center of the circular table to give the correct curve. Fig. 7 is a rear view of the scroll. The annular recess for the reception of a hardened abutment or tooth will be noted. A subsequent operation is the surface grinding of the back face with the hardened tooth in position in the annular slot.

The Internal Scroll

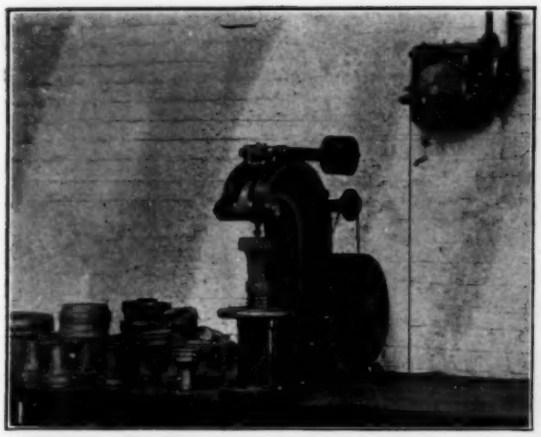
Fig. 8 shows the internal scroll which is attached within the external scroll. It is furnished with four cam-shaped projections which engage the notches in the back of the dies for positively withdrawing them from the work when the diehead opens. The internal scroll is made from a steel bar. A bar long enough for a dozen rings is chucked in a capstan lathe, turned, bored and cut off, an allowance being left for grinding. The scrolls are now placed on a mandrel and ground externally on a 12 x 36-in. universal grinding machine.

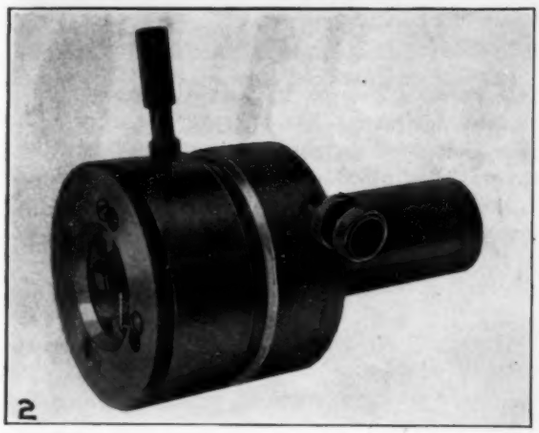
The next operation is milling the landing slots to afford clearance for the subsequent milling of the scrolls. Fig. 9 shows the finished milling of the scrolls on a No. 3 Herbert vertical milling machine. The fixture is also used for milling the curves on the outer scrolls, a special adaptor being fitted.

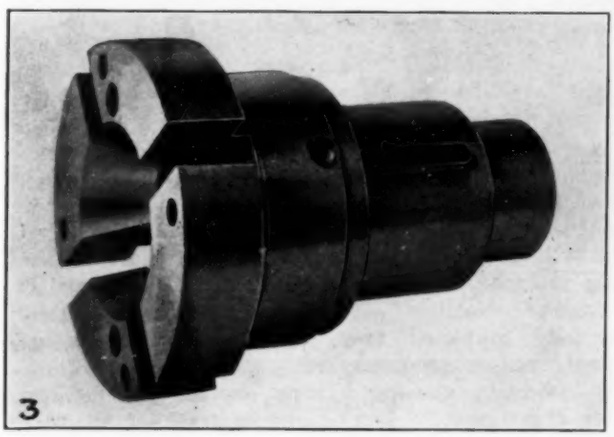
The front plate is of steel hardened and ground. It is attached to the body by four screws and is furnished with elongated or bayonet holes which permit of its rapid withdrawal without completely withdrawing the four holding screws. Fig. 10 shows the rotary surface grinding of one of the front plates. The plates are machined from a bar. A bar long enough for a dozen plates being bored and turned before cutting up into individual plates. The outside of the plate is knurled, the rear face is formed and the external diameter chamfered.

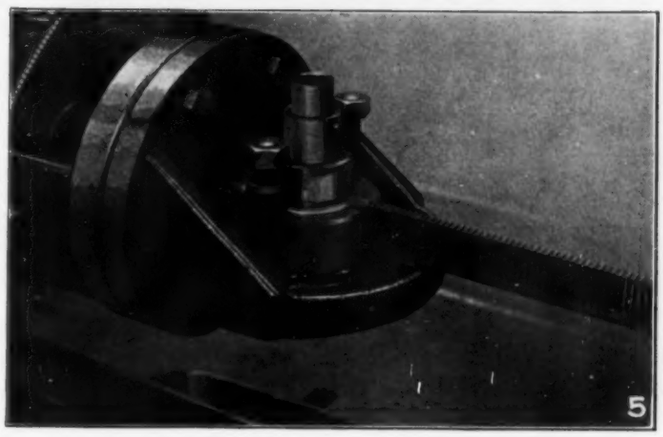
The Shank

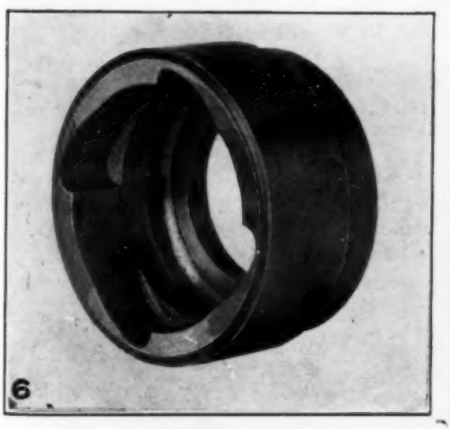
Fig. 11 shows the shank end of the diehead. The shank comes to the lathe in the form of a high-carbon steel forging. The forging is chucked by the big end, and is rough turned and drilled with a special box tool, as shown in Fig. 12. Another box tool is swung into











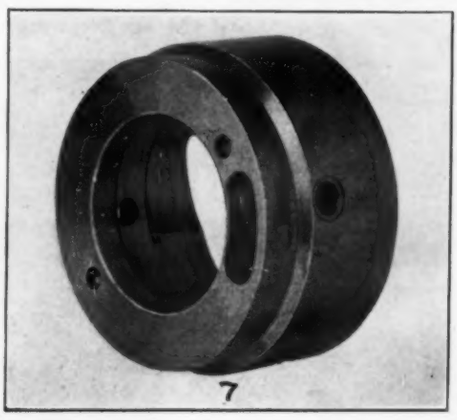


FIG. 1. TESTING THE FORGINGS. FIG. 2. A COMPLETE DIEHEAD. FIG. 3. THE BODY IN WHICH THE DIES ARE CARRIED. FIG. 4. MILLING THE DIE SLOTS. FIG. 5. FINISHING DIE SLOTS BY BROACHING. FIG. 6. THE EXTERNAL SCROLL. FIG. 7. THE EXTERNAL SCROLL (REAR VIEW). FIG. 8. THE INTERNAL SCROLL

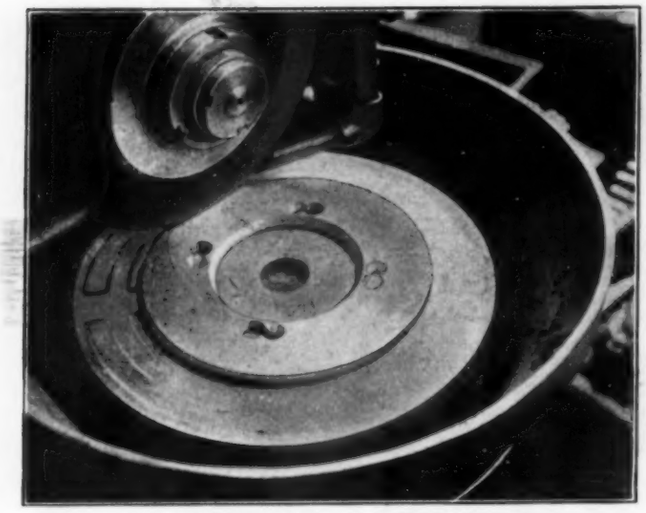


FIG. 10. GRINDING A FRONT PLATE

position when finish turning and rough reaming takes place. It is then rechucked in soft jaws on a capstan lathe and finish machined for external grinding as

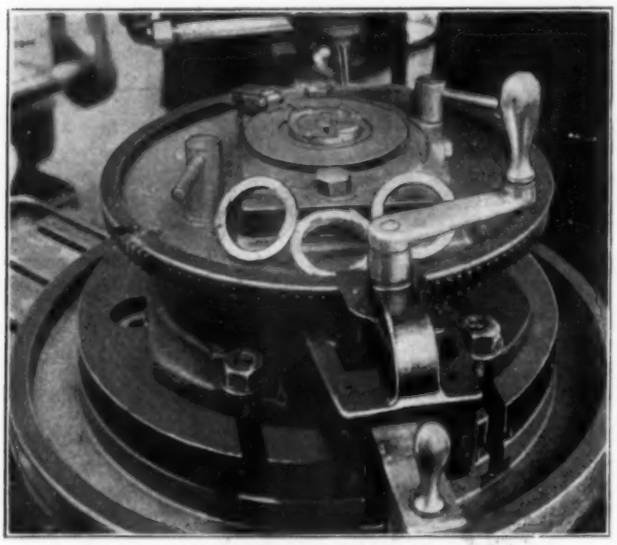


FIG. 9. MILLING THE INTERNAL SCROLL

shown in Fig. 13 which also shows an interesting capstan tool layout, attention being drawn to the trepanning tools. The job arrives at the machine, as per the sample on the feed shelf, the finished job being as per sample on the top of the turret.

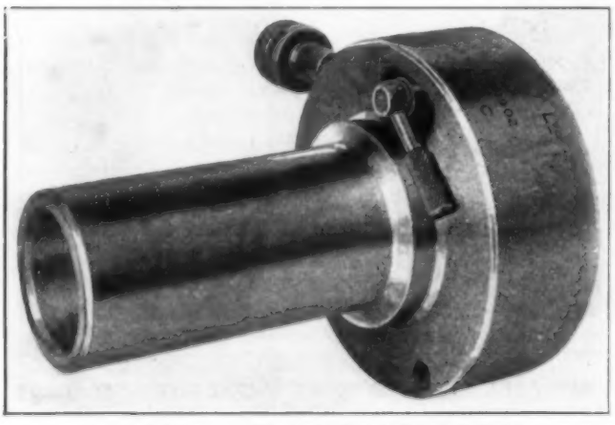


FIG. 11. SHANK END OF DIEHEAD

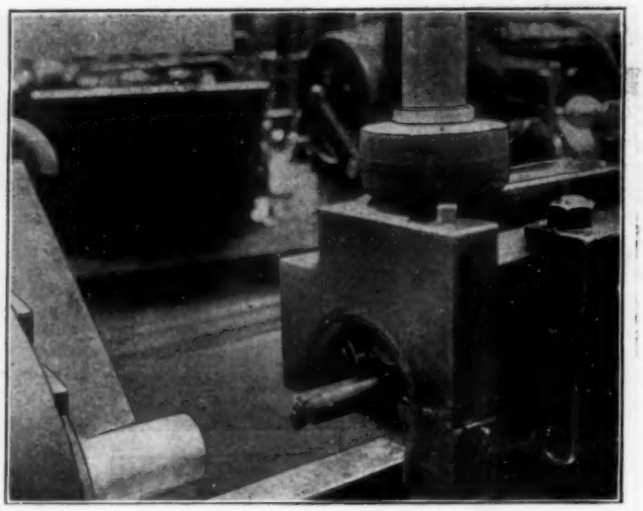


FIG. 12. MACHINING THE SHANK

A subsequent operation is grinding, see Fig. 14. The shank is placed on a mandrel similar to the one shown on the table of the grinding machine. The machine in question is a Herbert 12 x 36-in. universal grinding machine and the abrasive wheels used throughout the factory are of the Norton make. The next operation is on a Pratt & Whitney thread-milling machine where the boss for the adjusting ring is externally threaded, as shown in Fig. 15, where a finished piece of work may be seen at the top of the cutter head. Subsequent operations include drilling on sensitive drilling machines, the shanks being held in special jigs and a slotting operation on the body for the keyways.

The various units are assembled by fitters who have become specialists in the work, as they are constantly engaged in this one business of assembling "Coventry" dieheads. The various units going to make the complete "Coventry" diehead are issued against shop orders from the finished parts stores. Immediately a diehead part is machined from the rough it is placed in a wooden receptacle, and when such part is not being operated upon it is replaced in the box until it is finally completely assembled. The part is thus effectually protected from damage in its passage through the various processes.

An efficiency chasing system enables the finished stores department to keep a correct track of all work in progress. By this means the flow of work through the shops is regulated in an efficient manner.

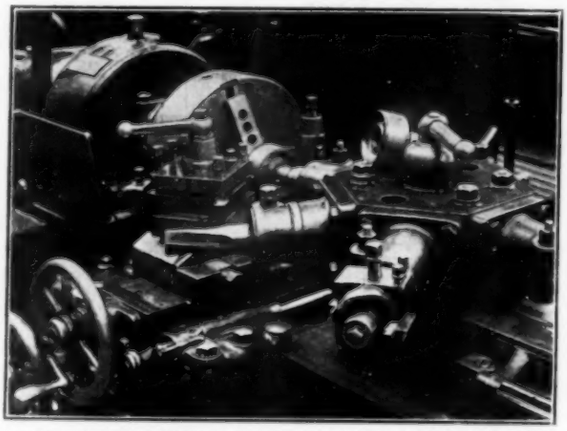


FIG. 13. FURTHER OPERATIONS ON THE SHANK

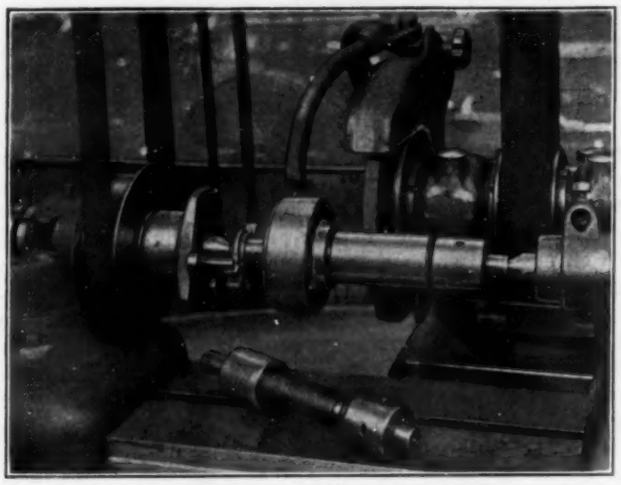


FIG. 14. GRINDING THE SHANK

To insure accuracy of form and pitch all the tools used in producing the milling cutter which cuts the teeth of the dies are made on specially designed machines and subjected to a rigid inspection after each operation, under a projection machine which magnifies

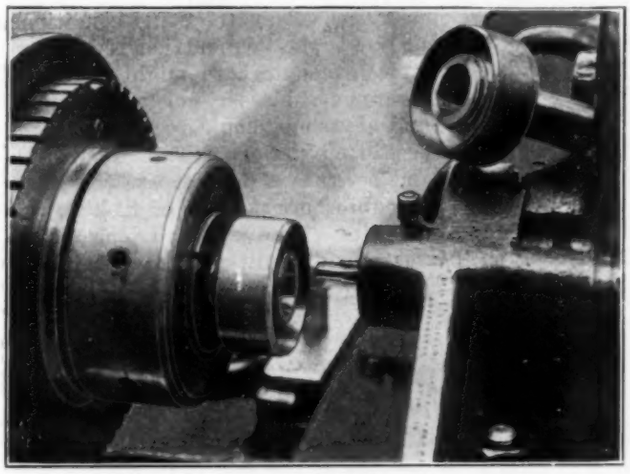


FIG. 15. THREAD MILLING FOR THE ADJUSTING RING

the image 50 times full size and provides means of testing pitch to 0.0001 in. Very close limits of accuracy are laid down and rigorously enforced. These milling cutters are hardened in a special type of electric furnace which prevents oxidization and reduces distortion to a minimum.

The teeth of the "Coventry" dies are straight, that is, they are produced by a milling cutter which traverses straight across the die. The result is that the straight-cut dies will produce accurate, well-finished threads. An important feature of the straight-cut die is that all four dies can be mounted in a very simple fixture and accurately sharpened at one operation.

All dies are made of high-speed steel except dies for copper which last longer when made of carbon steel.

Whittling Iron

The following interesting article is No. 19 of the research narratives issued by the Engineering Foundation:

In 1545, the *Mary Rose* capsized off Spithead, England. She carried some wrought-iron guns and cast-iron shot. After 292 years in the sea, on being brought into the air, the shot gradually became red hot, then fell to pieces. A similar fate overtook the *Royal George* in 1782 in the same locality, and 62 years later some iron guns were recovered from the wreck. After 133 years' submergence, some cannon and shot were brought up from the *Edgar*, also. It is recorded that the cast iron from the latter two vessels was generally soft, so that it could be cut with a knife, resembling plumbago. Wrought iron on these ships was not so seriously injured. While in this soft state, some of the old cannon were taken carefully to the Tower of London. In the Minutes of the Proceedings of the (British) Institution of Civil Engineers, about eight years ago, Major General Pasley records that after a time these cannon resumed their original hardness. The same authority declares that iron parts of pumps immersed in mineralized waters were similarly affected. Another authority states that the old guns mentioned were again fired. Cast-iron piles along the English coast likewise deteriorated.

In the Transactions of the American Society of Civil Engineers for 1915, Marshall R. Pugh narrates that "the cast-iron guns from some ancient pirate ship were brought up from the ocean depths off Holyhead in 1822, after the lapse of a century. They were quite soft, but hardened so much on exposure to the air that they were used to fire salutes to King George IV when he passed through Holyhead on his way to Dublin. These old guns were said to have given louder reports than any others!"

Old sea tales might be multiplied. Modern ship-builders, too, state that in repair work, cast-iron parts exposed to sea-water are frequently found in the condition described, at least in spots.

Iron pipes along the seaboard are so deteriorated by salt water as to need replacement, in some places, within a few years, whilst in other places a generation or even two may pass. This deterioration appears to be more rapid in tidal marsh land than in seaways. It has been learned, also, that coal ashes and certain industrial wastes deposited on the land, through leaching, cause the same unfortunate results. Likewise, pipes and other iron objects in alkaline, acid or saline soils, in many localities suffer deterioration. All kinds of iron are not affected, nor is the action uniform.

Narratives of such troubles could be written for many parts of our country and other countries. A little knowledge has been gained about this form of corrosion, and some methods for avoiding it partially have been developed. However, it is still a menace to many iron objects, jeopardizing valuable property, and, indirectly, human lives.

A more thorough investigation than has ever been undertaken is demanded. Engineering Foundation is endeavoring to organize a research that will get valuable results. Information concerning the trouble must be countered by scientific knowledge of causes and means for avoidance or resistance. Manifestly, it is undesirable to have iron in pipes or structures become soft enough to be whittled with a jack-knife and in extreme cases, as soft as putty.

Safety Code for Compressed Air Machinery

The American Society of Safety Engineers has been designated as sponsor for a safety code for compressed air machinery by the American Engineering Standards Committee. The code will include rules for the construction and use of compressors, tanks, pipe lines, and the utilization of apparatus where compressed air is the active agent. In accordance with the usual procedure, the code will be formulated by a sectional committee composed of representatives designated by the various bodies interested.

This work is being undertaken as part of a comprehensive program of safety codes in process of formulation under the auspices and rules of procedure of the American Engineering Standards Committee. The American Society of Safety Engineers was appointed sponsor for the code on the recommendation of the National Safety Code Committee.

Metal Cutting Tools—XVII

By A. L. DE LEEUW

(Continued from last week's issue.)

IN THE foregoing chapters an attempt was made to point out the principles involved in the cutting action of metal cutting tools without making much effort to go into details of construction. To do so would involve the cataloging of thousands of different tools, many of which have points of merit for the particular duty

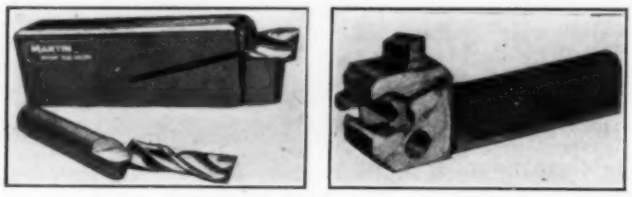


FIG. 293. (RIGHT) MONTSTREAM'S "TWISTO" TOOLBIT AND HOLDER. FIG. 294. (LEFT) MARTIN DRAWN SECTION LATHE TOOL

for which they were developed. It was intended to point out these principles and particularly the difficulties one may meet when constructing tools without due regard for them.

Some tools are constructed with an eye to better cutting qualities, others with a view of adapting them to some particular class of machine, still others for the purpose of quick replacement. Others again with a view to economy of tool steel, and again others so as to make them readily into combinations of tools. All of these considerations have merit but it would not be possible to describe all of the tools constructed so far, or even a small portion of them. However, there are a few existing tools which have certain points of general applicability or which embody some principle which makes them of general interest and a few of them will be pointed out here.

One of them is the lathe or planer tool made up out of drawn steel, shaped in such a way that some of the required angles are present without further effort, or which presents a number of cutting edges, or which permits of the simplest kind of grinding for the purpose of resharpening. Such tools, though generally not adapted to the very heaviest kind of cutting may be very useful from the standpoint of simplicity in regrinding or from the standpoint of economy in the use of tool steel. Figs. 293 and 294 show such tools.

Whenever an operation becomes standard in one or more industries it will be found that standard tools

FIG. 295. BRIDGE REAMER

will be developed, specially adapted to that operation. Fig. 295 shows a case in point. The tool shown here is the so-called bridge reamer. It is used for reaming out the holes in steel plates which are to be riveted together. Such holes may have been either punched or drilled, but in either case the degree of accuracy in regard to the size of hole and its location is of a rather low order and when the plates are bolted together preparatory to riveting it will be found that in many cases the two opposing holes do not match. The bridge reamer is used to bring the holes into alignment. It is provided with a taper part small enough at the end to enter the two holes even when there is a maximum of error. The taper part gradually removes the overlapping metal and the straight part then brings the holes to size. Such reamers must be able to stand very rough usage but do not require a high degree of accuracy. Many makes of bridge reamers are not even ground after hardening.

Another standard tool for a special operation is the well-known center drill shown in Fig. 296. As a rule these drills are made double-ended as a matter of economy. Each end consists of a short drill and a countersink.

Many other examples of tools might be found which were originally designed for some special purpose but which have become standardized by the fact that they are in common use in some industry.

Another development caused by the same conditions but along a different line is the introduction of built-up tools. As an example, a counterbore might be cited. A great many combinations of sizes of hole and counterbore are possible, and any shop should be in a position to make any of these combinations. This requires a great many tools and becomes a handicap to the small shop. The built-up counterbore permits of making unlimited combinations with a few standard tools. Fig. 297 shows such a system of built-up counterbores as

FIG. 296. CENTER DRILL

made by the Pratt & Whitney Co. The elements of such counterbores are the pilots, the counterbores and the shanks. This is going a step further than merely providing for the various combinations of sizes of holes and counterbores, by making allowance for the use of the tool on various machines.

A development along still another line is found in the tools with adjustable or interchangeable tool points or blades. The well-known lathe or planer toolholder such as the Armstrong, Lovejoy, O. K., Ready and Williams are instances of this development. In recent years this method of using interchangeable blades has been somewhat extended in other fields. In some cases provision is merely made for the removal of old and worn out blades and the substitution of new ones. In other cases a large part and generally the most expensive part of the complete tool is provided with a number of interchangeable blades to be used for various sizes or purposes. The Gisholt reamer, illustrated in Fig. 298, allows for the renewal of the blades and permits, to a certain extent, also of using the same body for more than one size. However, as a rule this tool is merely made with an eye to the renewal of the blades and not for the purpose of making it universal for all sizes. On the other hand, tools like the Davis boring bar or the Kelly reamers are constructed with the view of using simple tools of various sizes in a holder so

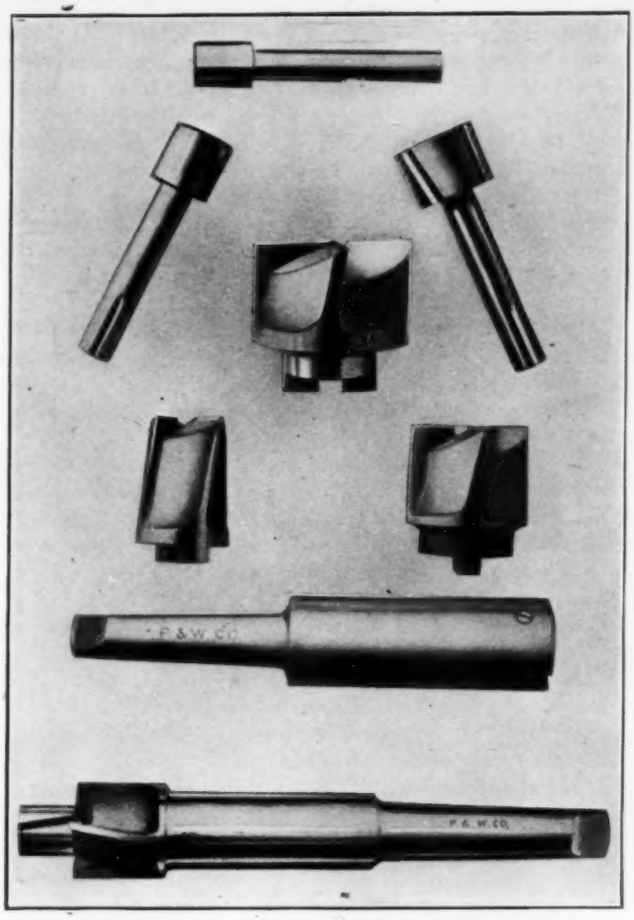


FIG. 297. BUILT-UP STANDARD COUNTERBORE

constructed as to permit of the ready adjustment of inserted blades. Some of the Davis boring bars have been illustrated in the chapter on boring tools.

Fig. 299 shows a Kelly floating reamer and Fig. 300 a complete outfit of reamers and bars as furnished by the Kelly company to meet the demand for all sizes from 1 to 5¾ in. A few holders or bars and thirty-five sets of roughing and finishing tools make combinations possible for any imaginable size between the outside limits. This result is reached by the interchangeability of the tools in the bars and by the fact that each tool has an individual adjustment of ¼ inch.

Standard outfits such as the one shown above are of rather recent origin. Until relatively a few years ago the machine shop used either standard tools with practically no adjustable features or tools constructed by or for them and adapted to some special operation only. The new line of adjustable tools is the result of the advance in manufacturing methods. The most advanced methods of manufacture, at least so far as production goes, were naturally found in shops where quantity manufacture was carried on. Gradually it began to be recognized that such methods could be employed even where the quantities were not so large as to justify the making of expensive special tools. The result was the gradual introduction of adjustable reamers, milling cutters with removable blades, multiple planer toolholders, threading dies adapted to a number of sizes, boring bars and combination tools.

A milling cutter which has the feature of ready adjustability of the cutting blades is shown in Fig. 301. The blades are grooved and are held in position by a grooved wedge. After resharpening this cutter a number of times and when the point has been reached where the blades do not project a sufficient amount beyond the body, the wedges are knocked out, the blades advanced one or two notches, and the wedges reinserted. This cutter is made by the Lovejoy Tool Company.

It is well to remark here that one should not expect too much from such adjustable tools. It is a disappointment to some people that a reamer must be resharpened after the blades have been set out, yet it is not reasonable to expect that this will not be necessary. With adjustable boring bars it may be perfectly proper to take a cut after the blades have been adjusted and without resharpening, but for a roughing cut only. To get the best results with a finishing cut it is advisable to resharpen the tool. Even with such tools as an inserted blade milling cutter one must not expect good results unless the cutter is sharpened as a whole. It is possible to take a cut without doing this, but the feed would have to be much reduced and the cutter would dull much sooner.

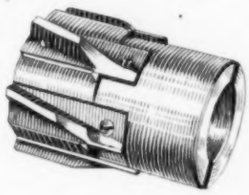


FIG. 298

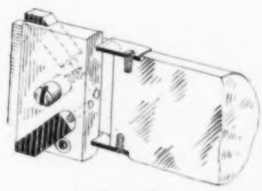


FIG. 299

FIG. 298. GISHOLT REAMER. FIG. 299. KELLY REAMER

A KELLY REAMER SET
TYPE B
35 ROUGHING REAMERS AND BARS
35 FINISHING REAMERS AND BARS
SIZES FROM 1" TO 5¾" EACH REAMER HAS
¼" ADJUSTMENT AND GIVES ANY DIAMETER
WITHIN A THOUSANDTH OF AN INCH
DIRECTIONS
REPLACEMENTS

FIG. 300. COMBINATION REAMER SET

In the chapter on reamers attention was called to the advantages of the spiral reamer. A peculiar adaptation of the principle is found in the taper pin reamer as made by the Gammons Holman Co. (see Fig. 302), which resembles a small helical mill and has, in fact, the same general action.

The small milling cutters used in the Anderson die cutting machine are another adaptation of the helical mill. They are shown in Fig. 303. In this case they are used as true milling cutters; they are so small and inexpensive that they are not supposed to be resharpened.

Fig. 304 shows a milling cutter particularly adapted to slotting and of a construction somewhat different from that recommended for this purpose in the chapter on milling cutters. The general underlying principle, however, is the same. Alternate teeth cut the sides of the slot and besides are set at right- and left-hand spirals so as to have rake on the side which is being cleaned up. Such cutters are well adapted to the purpose, provided no very heavy cuts are taken. Heavy cuts have a tendency to move the cutter back and forth on the arbor, and to cause a rough finish. For moderate sized slots they are quite successful.

An interesting boring tool is shown in Fig. 305. It is made by the Skelton Tool Co. As will be seen from the illustration it can be ground an almost unlimited number of times and will always present the same cutting angle by grinding it on the face. Such tools have been used by the writer for a number of years either before the Skelton tools were brought out or at least without knowledge of their existence. The advantage of this tool over the customary construction must be obvious. In the ordinary construction we have a small

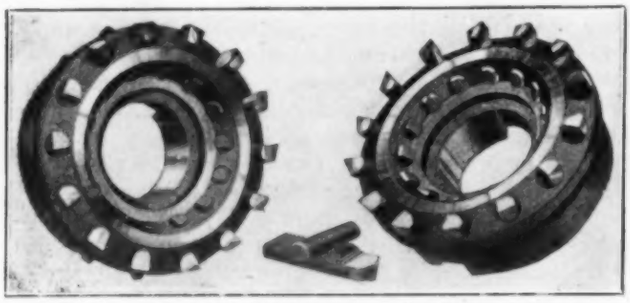


FIG. 301. LOVEJOY ADJUSTABLE MILLING CUTTER

bar with a still smaller piece of tool steel inserted in it, which must necessarily be very frail and can only be held in that bar by some small set screw or similar delicate construction. On the other hand, the Skelton tool is made all in one piece and does not need to be of delicate construction as it can be made almost as large as the size of the hole to be bored. It might seem that the first-mentioned construction has the advantage of an adjustability which the Skelton tool does not possess, but this is only apparently so. In the first place, it is exceedingly difficult to set out a delicate tool point to a predetermined diameter. It becomes a matter of trying and re-trying and measuring of the hole. The Skelton tool calls directly for the kind of construction which should be furnished for every boring bar, namely, an adjustable slide or holder. The amount of adjustment required after grinding is exceedingly small, as the reduction in diameter is merely due to the taper of the tool, so that if a few thousandths are ground off the front of the tool there may be a reduction of $\frac{1}{4}$ to $\frac{1}{2}$ of a thousandth in diameter of the hole.

Another tool which is rather out of the ordinary is the one shown in Fig. 306. It was constructed by the author with the idea in view of testing out the possibility of making tools with very fine contained angles. Such tools are particularly useful for finish turning long and slender work, provided that it does not have to come up to a square shoulder. The tool is merely a round piece of steel cupped out at the top and provided with a shank and shoulder. The shank fits in the top slide of the lathe and is held in position by a setscrew. The upper part is turned taper so as to provide the clearance angle. The writer has used these tools with a contained angle of 27 deg., which is very much below the corresponding angle of ordinary lathe tools. A tool of this description with such a very fine angle must, of course, be free from all vibration. The slightest vibration would break out the cutting edge, and for that reason it is not set in a long, projecting toolholder but direct into the heavy casting of the toolslide. Though it is true that such a tool cannot stand

FIG. 302. TAPER PIN REAMER RESEMBLING SPIRAL MILL

vibration, on the other hand it is also true that such a tool does not cause vibration.

The cutting action proceeds very smoothly and though relatively fine finishing cuts may be taken the chip will come off in a continuous ribbon without breaking up, showing that there must be a complete absence of vibration. Work which would require a back rest, if cut with an ordinary tool, can be cut without a back rest with this tool, and it will be found that there is an almost complete absence of spring in the work. This is clearly shown by the fact that there is practically no difference in size between the ends and the center of the work. The sharp angle of the tool causes it to work with very small power consumption, which explains why it does not break down at once. When the cutting edge becomes slightly dull it is liable to crumble. However, all that is necessary is to loosen the setscrew, turn the tool through a slight angle, and tighten up again, and a new part of the tool is being presented to the work.

The tool with which the writer experimented was $1\frac{1}{4}$ in. in diameter, so that its circumference was almost 4 in. When taking a cut 0.030 in. deep about 0.195 in. of the circumference was in action, so that theoretically it would be possible to shift the tool sixteen times before it was entirely out of action. However, when shifting this way it is not necessary to reset to diameter; so that

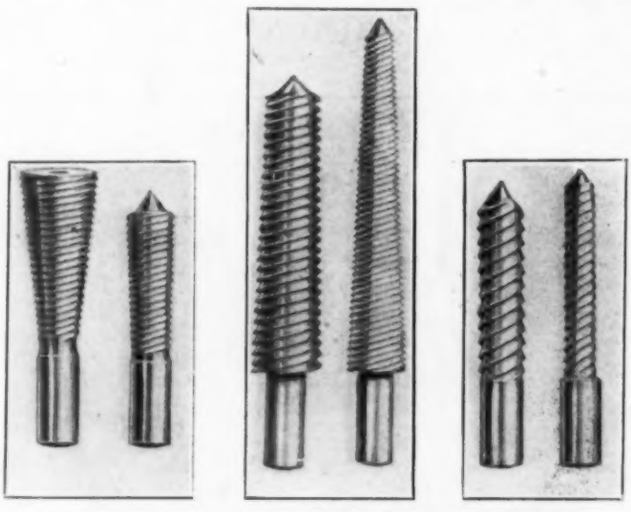


FIG. 303. MILLING CUTTERS FROM ANDERSON DIE SINKING MACHINE

the operation of changing over is a very short one. To regrind the tool, all that is necessary is to take some off the outside, in other words, reduce its diameter slightly. It was found that fairly heavy cuts can be taken at ordinary speeds, and that light cuts can be taken at very much increased speeds, due probably to

the absence of vibration. The possible speed was still further increased by running a copious stream of lubricant onto the work. The little cup on top of the tool was always filled with lubricant, thus cooling the chip after it came off the work and assisting materially in the general cooling action. A tool of this description might be made with a much extended shank and provided with, say, a worm wheel driven by a worm, so as to give it a rotating motion. In this manner no single point of the cutting edge would be kept in contact with the work for any length of time and it would be possible to obtain even higher cutting speeds or, if keeping the same cutting speeds, to make the tool stand up much longer.

Conclusion

The great improvements which have been made in machine shops in recent years have been mainly in machinery, handling devices and systems of control.

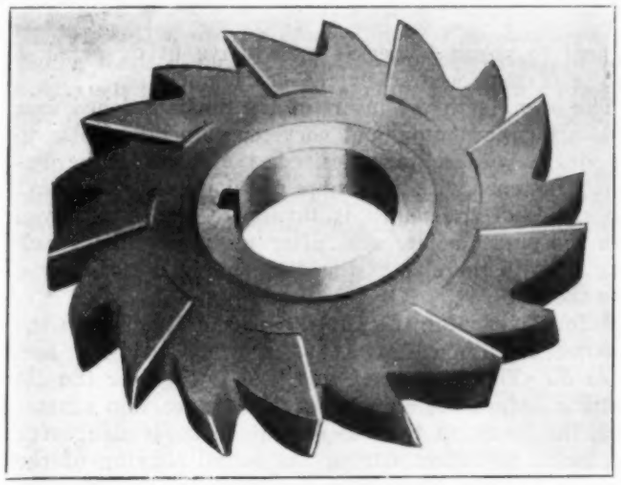


FIG. 304. SLOTTING CUTTER

Though many improvements have also been made in cutting tools, yet a wide field has been left for further development. Whatever improvements have been made so far, outside of the great change caused by the invention of high-speed steel, have been in the nature of toolholders, of combinations of tools and of means for handling and adjusting them; the tools themselves have changed very little from what they were a generation ago. This is probably caused by the fact that our present-day tools are the result of slow evolution. Our planer, lathe and boring mill tools have developed from the old-time hand tools by such imperceptible stages, and the machines on which they were used have developed with them in such perfect unison, that there was never the need of developing tools along entirely new lines. When a new method of machining was invented requiring at the same time a new machine and a new tool, then there was a sudden striking development. Instances of this kind may be found in the gear and thread hobbing machines. The entire operation was new, and machine and tool were developed together. But in the lathe, boring machine or planer such need did not exist and the tools are still what they always have been with hardly any apparent change.

We are all aware of the fact that nothing limits the performance of a tool so much as overhang, and yet our lathes and planers are so constructed that there is no possibility of avoiding this injurious feature. Nor do we have any means of setting a tool in a lathe to diameter or to height or to the proper angle. In short, we still depend entirely on the skill of the individual operator for the correct setting of his tool. Human inertia is still holding up the use of machines for the correct sharpening of planer and lathe tools and, in all probability, such tool-grinding machines will be the

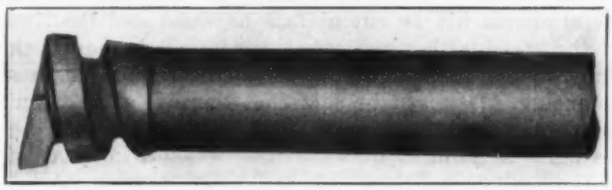


FIG. 305. SKELTON BORING TOOL

exception rather than the rule in the average shop until the machine in which the tool is to be used has been provided with means for setting it so as to make the proper use of the proper angle.

There has been an unlimited number of improvements and developments of metal cutting tools, but not in the line of their essential requirements. It might be asked what are the essential points which should be improved. To answer this question we must forget for a moment all practical considerations and place ourselves in fairyland where all our wishes will be fulfilled and where no difficulties and obstacles exist; and this is the kind of metal cutting tool we would get in fairyland, provided that fairies know what metal cutting tools are:

The tool would require very little power to remove a given amount of metal. In fact, no power would be required at all except that which is necessary for the separation of the chip from the work.

The pressure exerted by the tool against the work would be so slight as not to cause any perceptible spring, and as a consequence, machine tools could be of very much lighter construction and easier of manipulation, without danger of distortion or vibration.

Tools would be made with very small contained angles, and yet would not break down under the cut.

Unlimited speeds would be permissible.

Feeds would only be limited by the depth of scallops

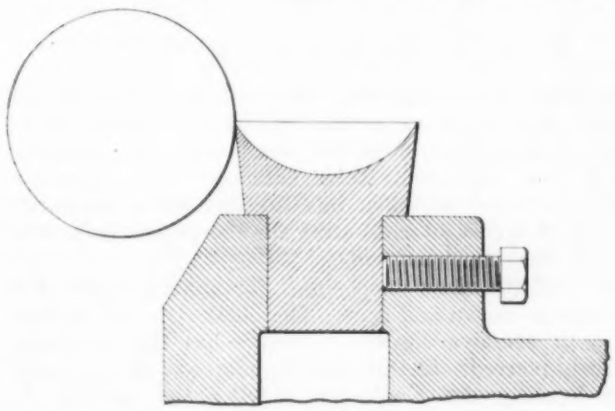


FIG. 306. CUPPED TURNING TOOL

we would get in the work and, this being a matter of geometry, it would be beyond the power of even the fairies to change this.

Of all these desirable things but a very small portion has come to us. It still takes an inordinate amount of power to remove metal; it is still impossible to make metal cutting tools with fine edges; we still must make machine tools excessively heavy and clumsy in

order to minimize the effect of our clumsy cutting tools.

Except what the invention of high-speed steel has done for us we have made but very little progress along the lines of speeding up. With the exception of the effects of stream lubrication in milling, and the rotary lathe tool, no experiments along this line are known to the author. And yet there is no real reason why metal should not be cut as fast as wood and the limit of the speed with which wood can be cut is merely the limit of speed of the machine and the requirements of balancing. It might be said that there is such a limit in metal cutting because a tool becomes too hot, but we must not forget that the tool becomes hot because of the faulty conditions that still exist in the tool.

There are but a few recent developments which can be mentioned here as being improvements in the essentials of cutting tools. Among them are the developments of the Gun tap, the Bath finishing tap, the Vauclain twist drill in which the central web is no longer the cause of crushing of metal at the center of the hole, and the wide spaced milling cutters. Beyond this all other developments and improvements have been along the lines of manipulation, setting, combination, etc. And though we should be thankful for all such improvements and should look forward to more of them, yet the real field of improvements in metal cutting tools by careful analysis of their elements has barely been touched.

Notes on the Design of Shaving Tools

By HUGO F. PUSEP

(Continued from last week's issue.)

IN DESIGNING dies for shaving only a part of the contour of a blank the designer will have to analyze each problem separately. It is to be assumed in the first place that if a blank is to be shaved, there is reason for accuracy and interchangeability. Also, that a common blanking die has been employed for producing the blanks and therefore as the blanking die wears or is ground at each resharpening the blanks will naturally vary somewhat along their contour. This probable variation must be taken into account while designing the shaving dies so as to allow for the proper balancing of the shaving operation.

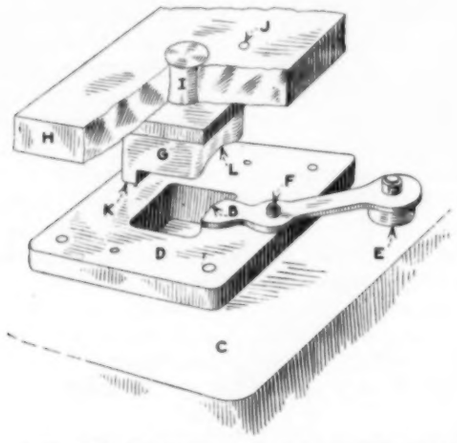


FIG. 6. DIE FOR SHAVING A PART OF THE CONTOUR

One of the most simple dies for shaving part of a contour is shown in Fig. 6. The blank *A* is the product of a progressive die and therefore has the two holes already pierced. In this case the pierced holes are used for locating the blank for shaving the contour *B*. Wherever pierced holes can thus be utilized they afford an excellent method of always keeping the shaved contour in correct relation to the rest of the blank.

Although the die shown in Fig. 6 is somewhat simple, it has all the characteristics of any shaving die of this type. The cast-iron die-shoe *C* has on its upper face a hardened tool steel insert *D*, screwed and doweled into a milled pocket. A shouldered stud *E* set into the die-shoe, and the pin *F* driven in the insert, form the locating medium for the blank. The shaving punch *G* is held to punch holder *H* by a drive fit on shank *I* and is further secured by the dowel pin *J*.

The opening in the insert of the die is finished first and, after hardening and correcting it by honing to the degree of accuracy desired, the insert is permanently fastened with the screws and dowels shown. Next the shank of the punch is turned to size and driven into the punch holder and, after machining the punch very near to the size of the die opening, it is sheared into the die.

Before hardening the punch a part of it towards the shaving edge is cut away as shown, leaving a heel as at *K*. The purpose of this heel is to enter the die opening before the shaving edge *L* comes into contact with the blank so that there will be no tendency for the punch to deflect during the actual shaving of the contour *B*, with consequent detriment to the accuracy and finish of the shaved part of the blank.

Balancing the Shaving Operation

Dies that shave a part of the contour of a blank must be designed so that the blank is properly "balanced." A study of Fig. 7 will make this term quite clear. At *A* is shown an abbreviated plan view of the shaving

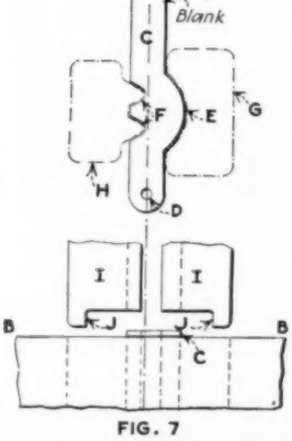


FIG. 7

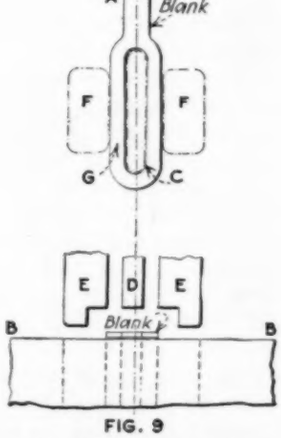


FIG. 9

FIG. 7. A BALANCED DIE SHAVING TWO OPPOSITE PARTS OF CONTOUR. FIG. 9. SUPPORTING SIDE WALLS OF SLOT AGAINST PRESSURE OF SHAVING PUNCH

die and at *BB* a section of the punch and die combined. The blank *C* is located from the pierced holes *DD* and is to be shaved along the circular contour *E* and also around the two notches *F*. Die openings are shown in view *A* by the dotted outlines *G* and *H*. Punches *II* have heels *JJ* which enter the die openings in advance of the shearing edge and guide them during the shaving operation.

In this case the blank is shaved at two opposite points of its contour and is, therefore, not subject to deflection in either direction. Had this blank, however, been shaved on one side only, the shaving punch would have had a tendency to bend the blank away from itself during the shaving. This is especially true after the shaving punch has become slightly dulled. The result of this would be an inaccurate contour after the blank has resumed its original position at the completion of the shaving operation. In this example no such inaccuracy occurs because the two shaving punches *II* "balance" each other and hold the blank perfectly.

In a case where the shaved blank does not balance itself some other method must be used to retain the accuracy of the shaved contour. The sketch, Fig. 8, shows an end of a lever blank *A*, the elongated slot *B* of which is to be shaved. The die opening in this instance is worked out as shown by the dot and dash lines *C*; the shaving punch being also of the same form. Although only the straight sides and the bottom

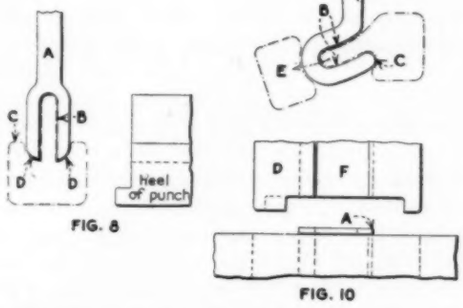


FIG. 8. ANOTHER METHOD OF BALANCING A SHAVING DIE. FIG. 10. TO PREVENT THE BLANK FROM BECOMING DISPLACED

of this slot need to be accurate, the die is so constructed that a shaving cut is likewise taken off the radii *DD*. By making the die in this manner any tendency for the forks of the blank to spread while the slot is being shaved is eliminated.

Shaving Dies with Supporting Punches

The plan view *A* and section *BB* in Fig. 9 show how it is possible to prevent a blank from spreading when a slot *C* or similar contour, the walls of which are comparatively springy, is to be shaved. Here we use three punches; the slot shaving punch *D* and the two supporting punches *EE*. The purpose of the latter is to shave along the outsides *FF* of the slot walls; extra stock being left at these points for the purpose. In this way the slot walls *G* are rigidly confined between the slot shaving punch and the two supporting punches. The cutting edges of all three punches must be ground to the same height, so that they may begin cutting simultaneously.

Sometimes a modification of methods shown in Figs. 8 and 9 must be employed, as will be seen by studying Fig. 10. Here is a hook in the end of blank *A* which must be shaved along edges of the radial slot *B*. The end of the hook is kept from spreading by continuing the shaving cut around the radius *C*. Although this method will prevent the spreading of the hook it will not insure against the blank being pushed bodily in the direction of the dotted arrow. For this reason an additional supporting punch *D*, working in the die open-

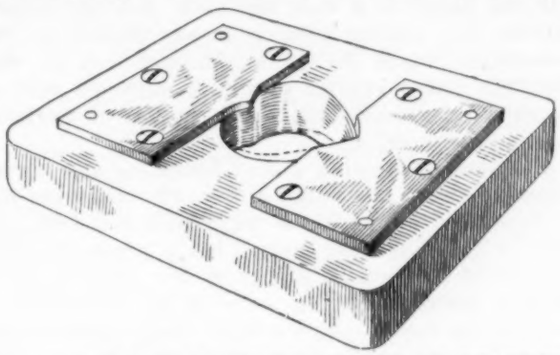


FIG. 11. THE USE OF NESTING PLATES OR SET-EDGES

ing *E*, is provided. This punch takes a shaving cut along the back of the hook in concert with the slot shaving punch *F*; thereby interlocking the blank between them and insuring accurate results.

Various Methods of Locating Blanks for Shaving

What is known as "nesting" a blank is shown in Fig. 11. It consists of two nests, or "set-edges" as they are often called, which are made of hardened tool steel to resist wear better. The die shown in this sketch is of the push through type, the blank being a heart-shaped cam with a central hole. The set-edges are of the same thickness as the blank, and filed to fit the contour of the rough blank at opposite points. Then the screw and dowel holes are transferred from the hardened die and finally the set edges hardened and secured to the die.

While the shaved blank is pushed into the die, the shavings remain on the edges of the die and are brushed off after each stroke of the press. Where compressed air is available, a nozzle set close to the die face and arranged so that it will emit a blast of air as the punch is ascending, will dispose of shavings very effectively. These shavings very rarely resemble a continuous ring, but mostly break up into fragments and therefore seldom give trouble by clinging to the punch. There are some shapes of blanks, however, such as gear teeth or narrow slots along the contour, that will cause the shavings at these points to ride up the punch. Trouble from this source may be very effectively prevented by providing a simple spring stripper that will push the shavings off the punch at each stroke of the press.

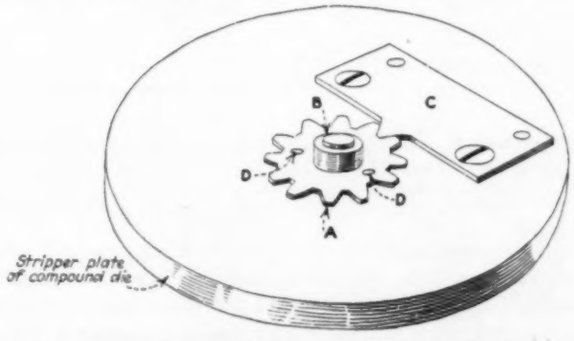


FIG. 12. A LOCATING PLATE ON THE STRIPPER OF A COMPOUND DIE

A safe rule to go by in designing set-edges is to have as little of them in contact with the blank as practical and still be sure of positively locating it. By so doing the loading and unloading is made easy; also the keeping of the die clean during the shaving operation becomes a much more simple task. A study of Fig. 11 shows that while the contact of the set-edges with the blank is a safe minimum, yet the latter is securely held against moving in any direction. It is these minor details that if the designer does not watch them will cause heavier operating expenses and consequently costlier product, if not the loss of markets to the manufacturer.

A method of locating a gear blank for shaving in a compound die is illustrated in Fig. 12. Here the blank *A* is centered over a pin *B* which is a drive fit in the punch. The single set-edge *C* has a projection fitting into one of the tooth spaces as shown. In this way the blank is always lined up correctly in relation to the teeth of the punch. As the holes *D* are pierced simultaneously with shaving the teeth it does not matter which tooth in the blank is used as a locator.

When a blank is comparatively symmetrical in contour it is often impractical to nest it for shaving. Such a blank is shown in Fig. 13. The high point *A* in this case is the only deviation from a perfect circle. The contour of this cam blank will have to be shaved all around; also the hole *B*. In order to do this successfully the following method of procedure is recommended. The rough blank is produced in a progressive piercing and blanking die which pierces the two holes *C C* and the large central hole *B*, the latter being left undersize for a subsequent shaving operation. These locating holes are pierced in order to facilitate the second operation, which is that of shaping the contour of the cam by shaving it all around. In planning the sequence of operations of various blanks it is often necessary to pierce one or two holes for locating purposes. Care must be taken to place these holes in such a position that they do not interfere with the function of the part in the assembled machine.

Advantages of Two Shaving Operations on One Blank

Where smoothness and accuracy in contour are the primary requisites it is advisable to shave a blank twice. As a general rule any blank of half-hard stock and 0.080 in. in thickness or over should be shaved

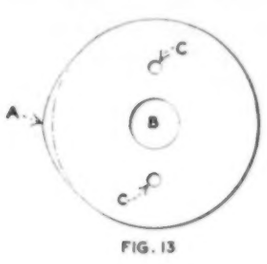


FIG. 13

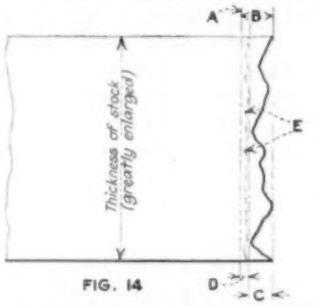


FIG. 14

FIG. 13. ON SOME PIECES IT IS NECESSARY TO PIERCE SPECIAL HOLES FOR LOCATING. FIG. 14. STUDY OF CONDITIONS THAT MAKE SECOND SHAVING OPERATION NECESSARY

twice, if permanency of shaved contour is desired. For a more thorough understanding of the fundamental reasons for this let us refer to the diagram in Fig. 14. The ragged edge of the rough blank presents a series of irregular ridges, which it is our object in shaving to cut off. If the line *A* represents the finished contour of the blank, then in order to cut off the ridges in one operation we have to take a cut which is represented as of thickness *B* at some points, so that we may eliminate all the torn surface. There is, however, a limit to the thickness of a shaving cut; or in other words, if it is attempted to shave too much at once the resulting surface instead of being smooth, will be more or less rough.

The object of the first shaving operation then is to remove most of the stock, leaving only a light finishing cut for the second shaving die. So instead of removing the entire stock *B* in one operation we would have the first shaving die to take the cut *C*, representing

TABLE I

Allowance for one Shaving Operation

MATERIAL	SOFT STEEL	¼ HARD STEEL	½ HARD STEEL	⅝ HARD STEEL	HARD STEEL	GERMAN SILVER AND BRASS
Allowance in percentage of thickness of stock	5%	6%	7%	8%	9%	9%

NOTE:- Minimum allowance for one shaving operation is 0.002

TABLE II

Allowance for Two Shaving Operations

MATERIAL		SOFT STEEL	¼ HARD STEEL	½ HARD STEEL	⅝ HARD STEEL	HARD STEEL	GERMAN SILVER AND BRASS
Allowance in percentage of thickness of stock	1st shave	4%	5%	6%	7%	8%	8%
	2nd shave	2%	2½%	3%	3½%	4%	4%
Total allowance for two shaving operations		6%	7½%	9%	10½%	12%	12%

NOTE I:- Minimum allowance for 1st shaving operation is 0.003
" " " 2nd " " " " 0.015

NOTE II:- Wherever a supporting punch is used, allow 9% of thickness of stock for the supporting punch to shave at each operation.

about two-thirds of the entire stock to be shaved. The resulting contour, if examined closely, will show some small ridges *E*. When the remaining stock *D* is removed in a second shave the contour of the blank will be left of mirror-like smoothness and finish. With two shaving operations it is entirely possible to shave the contour of blanks ½ in. in thickness, and to obtain a finish and accuracy not even excelled by careful milling.

Finishing precision machine parts by shaving is by no means a new industry. Strange to say, however, there is no uniform rule as to the amount of stock to leave for shaving, taking into consideration the thickness of the shaved blank and the quality of material. The first step toward this standardization made, according to the writer's knowledge, was in a form of tables published in the last edition of the "American Machinist's Handbook" where the allowances for one and two shaving operations are given for various grades of steel, etc., up to 0.125 in. in thickness.

In many shops this question of allowances is left to the individual diemaker. Now an experienced diemaker can acquire the knack of leaving just enough for the shaving operation but it is a purely personal knowledge and will have to be learned over again by every would-be diemaker. This process, naturally, means many a spoiled die, which is money thrown away. Even in the tool designing departments of up-to-date factories wide discrepancies occur in shaving allowances specified by different designers.

The accompanying Tables I and II give the proper allowance for one or two shaves. These tables are com-

piled upon a percentage to thickness of stock basis for different hardnesses of steel and also for german-silver and brass. In this form they can be instantly applied to any stock by performing only one multiplication, that of thickness of a known quality of stock by the given percentage.

As an example: What is the shaving allowance of 0.0625 in. half-hard steel? Answer: 0.0625 x 0.07 = 0.004375. We discard the three last figures because they are equal to less than one-half thousandth. If the figures following the 4 had been more than a half thousandth our allowance would be 0.005 inch.

From the foregoing example it will be seen that the simplest of arithmetic is all that is required. From these tables of percentages other and more extensive tables can be worked out if desired, giving after each thickness of stock the proper allowance in thousandths of an inch. These tables can then be blueprinted and given to individual designers and diemakers

The footnote at the bottom of Table I means that nothing less than that 0.002 in. should be left for one shaving operation, notwithstanding the fact that the calculation shows a smaller quantity. Two thousandths has been found by practice to be about the least amount that can be shaved successfully in one shaving operation. The first footnote under Table II signifies the same thing in relation to a double shaving operation, with the exception that the minimum for second shave is 0.0015 inch.

As the metal removed by the supporting punch is primarily for support only, the allowance for this is made 9 per cent of thickness of stock, regardless of quality or hardness of stock as indicated by second footnote under Table II.

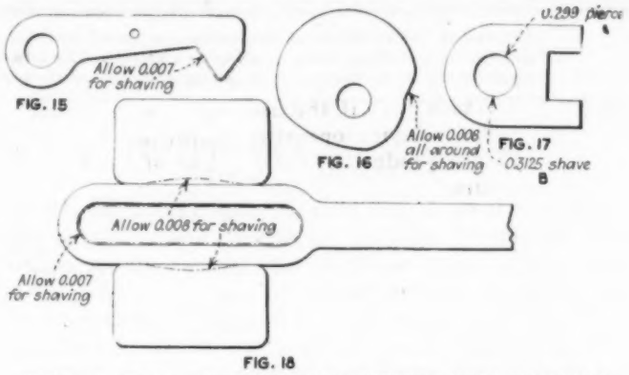
By standardizing the shaving allowances, any quality of finish can be duplicated whenever necessary, and the time lost in arguments between the diemaking department and the drafting room can be used for more productive purposes.

How to Show Shaving Allowances on Drawings

Even with complete tables of shaving allowances in both the designing and the diemaking departments there is always the possibility of misunderstandings unless some uniform method of showing the allowances on die drawings is adopted. Figs. 15 to 18 illustrate several ways of doing this. With slight changes of wording to suit the phraseology of the individual shop they represent fair examples toward uniformity.

Fig. 15 shows a pawl blank with the dot and dash marking where the shave is to take place. An arrow from a note, pointing to this place, will prevent any one from misunderstanding the meaning of the designer. The dot and dash way of showing the part of contour to be shaved is standard in many shops. When a blank is to be shaved all around it is not necessary to inclose it in the dot and dash line, but a note, as in Fig. 16, and the arrow are sufficient.

One of the most common causes of mistake is the way in which the shaving allowance of a round hole is usually indicated. If the blank shown in Fig. 17 is of half-hard 0.093-in. sheet steel and must have a hole pierced which afterward will be shaved to 0.3125 in. in



FIGS. 15 TO 18. METHODS OF DESIGNATING SHAVING ALLOWANCES ON DRAWINGS

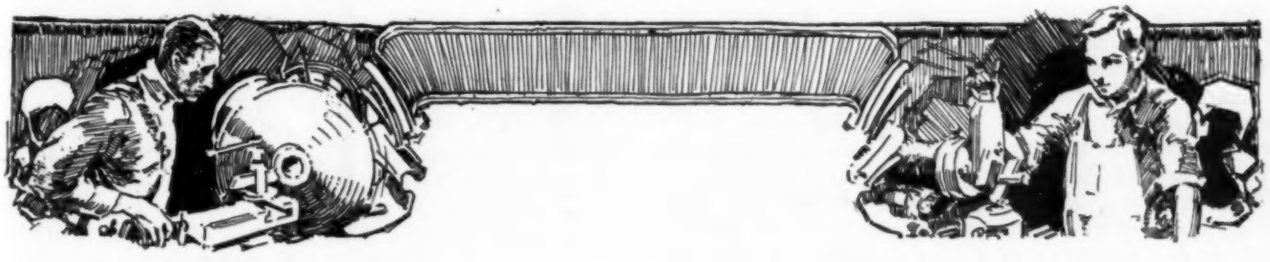
diameter, subtract 14 per cent of thickness of stock from finish diameter of hole and indicate as shown at *A*. Any other note in this case would be misleading. When shaving a hole to size indicate as at *B*.

The correct way of indicating shaving allowance in an oblong slot is illustrated in Fig. 18. Here the standard dot and dash line is used both for the slot and the allowance for supporting punches.

These few examples of indicating shaving allowances are for the purpose of impressing upon the designer the importance of making his meaning so clear with short and to-the-point notes that there will be no possibility of a misunderstanding; no one disputes the fact that a mistake made in the shop is far more expensive than the one made in the drafting room.

Copper Resources in U. S.

Recently when an estimate of the surplus copper stocks in the United States was requested of the United States Geological Survey, definite information was not available. Since then Director Smith has had the opportunity of examining the production statistics of the copper producers as compiled by their own agency. These include details of the stocks of copper on Sept. 1, and Director Smith reports that these show the available supply of copper, including both the pig copper at the smelters and the refined copper ready for the market, as 405,051 short tons. Nearly one-half of these stocks, however, was held at the refineries in trust for the Copper Export Association for export alone, and is thus not available for domestic consumers. These figures do not include the working stocks of copper in transit and in process of refining, which are now much lower than at the beginning of the year and apparently are reduced to a minimum.



Ideas From Practical Men

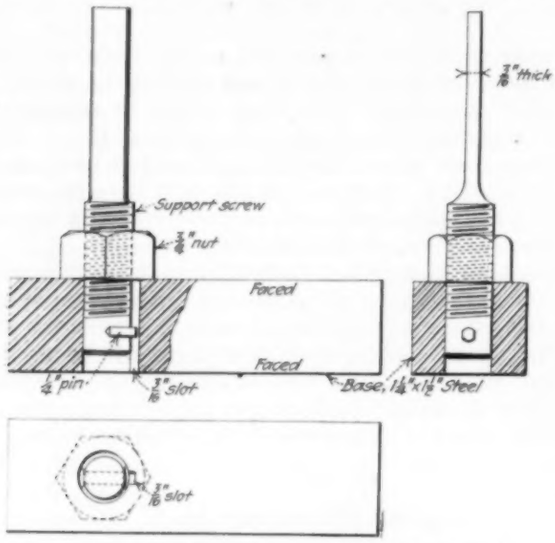
Devoted to the exchange of information on useful methods. Its scope includes all divisions of the machine building industry, from drafting room to shipping platform. The articles are made up from letters submitted from all over the world. Descriptions of methods or devices that have proved their value are carefully considered and those published are paid for.

A Cutting-Off Tool Support

BY WALTER CANTELO

The article by A. J. Cawse on page 150 of the *American Machinist*, entitled "Support Your Cutting-Off Tool Solidly," reminds me of a somewhat similar condition I was up against during 1913.

The work being performed was the manufacture of 4.70-in. shrapnel cases, which were machined complete and then cut off from heat-treated steel bars that had



SUPPORT FOR CUTTING OFF TOOL

been rough machined to approximately 5 in. in diameter before being heat-treated. The physical qualities of the metal in the bars were about as follows: Elastic limit, 90,000 lb. per square inch; tensile strength, 130,000 lb. per square inch; elongation in two inches, 17 per cent; contraction of area, 45 to 50 per cent.

The cutting qualities of the metal were much more severe on the tools than would be met in machining annealed tool steel and since the work was done on a piecework basis it was necessary that as little time as possible be wasted on each operation. Among other things that had to be given careful consideration was a method of supporting the cutting-off tool rigidly and as nearly under the cutting point as possible, in order that the power crossfeed could be used and the cutting-off hurried along with little tool breakage.

The form of support finally used for the work was as shown in the illustration. The base was cut off from a steel bar of 1¼ in. square section, and after facing it on opposite sides, the hole was drilled to form a sliding fit for the ¾-in. supporting screw, and a slot was cut the full length of the hole to engage the stop-pin in the screw.

The screw was made from a grade of steel that could be oil hardened and tempered, to stiffen it and prevent bending and upsetting as far as possible. A hole was drilled near the lower end of the screw for a ¼-in. stop-pin, and after the pin was driven into the screw, the portion projecting was filed to slide freely in the slot. The nut was made a close fit for the screw and faced on the lower side to reduce springiness to a minimum.

In action, the base rests on the cross-slide of the lathe with the screw directly below the blade of cutting-off tool near the cutting end and adjusted to bear lightly against the under side of the blade.

This form of support gave us fine results and I am glad to pass the idea along for anyone that may care to try it.

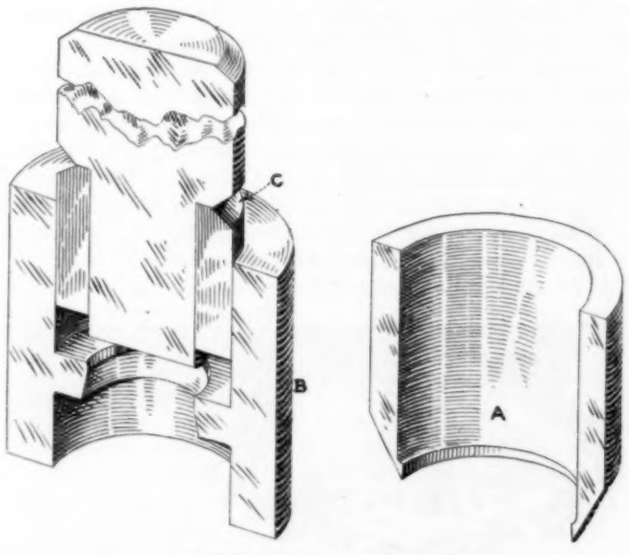
An Improvised Set of Washer Tools

BY GEORGE WILSON

It not infrequently happens that a few washers of odd size and thin stock—either fiber, metal, or other material—are required for a special purpose, and with no punch press available the job of producing them is a bothersome one. Needing a hundred or so of such washers 1⅛ in. in diameter, $\frac{1}{16}$ in. thick, and with a ¾-in. hole, I made the tools shown in the illustration to get them out.

As the material used for the tools was mild steel, case-hardened in the usual manner, and all the work of making them was done in the lathe, the entire cost of the job was less than it would have been for even a makeshift method of making the washers that would not have produced results nearly so satisfactory.

A ring punch *A* was made, with the hole of the correct size to cut the blanks properly, and bevelled upon the outside to secure a keen cutting edge. This was used by laying a sheet of the material upon a babbitt block, setting the punch upon it, and striking with a



IMPROVISED WASHER TOOLS

lead mallet. The hole through the punch was tapered slightly toward the upper end to permit the blanks to pass through easily.

The tool for making the hole in the washers was a little more complicated. A piece was bored as at *B* to fit the blanks and a shouldered punch fitted to slide neatly therein. A shoulder at the bottom of the full-sized hole was bored to the size required for the hole in the washers and the cutting end of the punch fitted to it, leaving about 0.003 in. clearance. This hole was also tapered slightly toward the bottom to allow the punchings to go through without sticking.

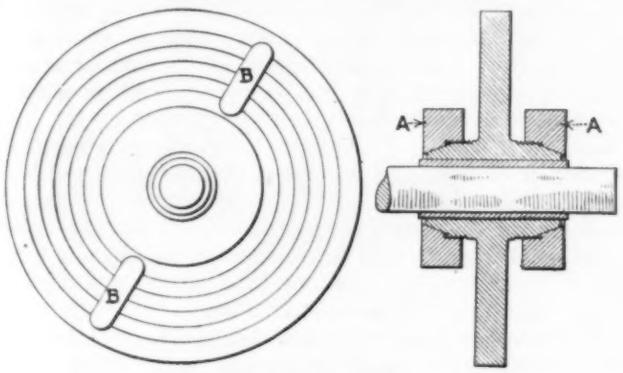
To strip the washers from the punch, the sleeve *C* was made to fit over it. The corners of the shoulder of the punch and the upper end of the sleeve were bevelled to allow for the insertion of a screwdriver, by which means the washers were easily stripped off the punch without bending them.

The device was used in an arbor press and completed the job very quickly and satisfactorily.

A Balancing Disk

By P. H. White

The balancing of high-speed rotating parts is an art which determines in a large measure the smoothness with which the completed mechanism will run. The



BALANCING DISK

standing, or static, balance, may be accomplished very simply by mounting the part on its shaft and placing the latter upon parallel straightedges as is ordinarily done with pulleys and flywheels. To obtain the proper running balance, the disk shown in the accompanying illustration has been designed.

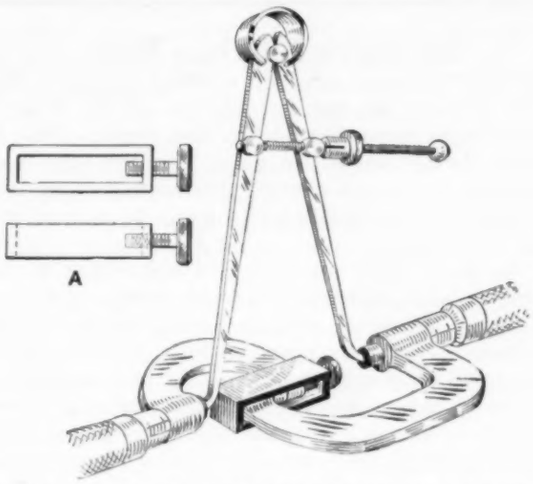
In using this disk it is necessary, of course, that the device itself be in perfect running balance and that it be mounted concentrically with the axis of rotation of the part to be balanced. As shown in the illustration, the disk is made with a projecting hub on each side which is bored out to the desired size to form a turning fit on the shaft which is being balanced. The inner part of the hub is threaded to take the nuts *AA*. The outer ends of the hub are tapered, as are also the outer end of the bore of the nuts. Both ends of the hub are split in four places to allow them to spring slightly. By tightening the nuts, the tapered portion forces the ends of the hub tightly to the shaft.

The two radial slots *BB* are used for clamping the necessary balancing weights. The concentric rings marked on the face of the disk serve to locate the balancing weights at a given distance from the axis. By using split bushings the disk may be adapted to several different sized shafts.

Setting Inside Calipers Accurately

By Earl Stevens

To set inside calipers accurately for measurements above 2½ in., given a 1- and a 2-in. micrometer, it is only necessary to make the small clamp, shown at *A* in



USING TWO MICROMETERS TO SET INSIDE CALIPERS

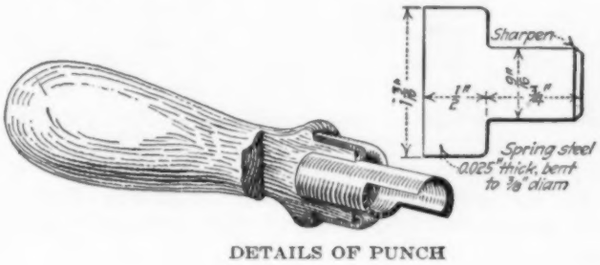
the sketch, to hold the two frames together. The clamp is simply a piece of ⅝-in. round cold-rolled steel with a suitable slot to slip over the frames, and a setscrew to supply the clamping pressure.

Cutting Index Marks in Handbooks

By John S. Carpenter

When I want to use a handbook, I usually want to find the place quickly and I haven't time to wade through a table of contents at the back of the book. Some time ago, an ingenious friend of mine made a punch for cutting semi-circular index marks in the edge of a book so one can find the place very quickly and also make an index to suit his own peculiar needs. As shown in the sketch, the device consists of a file handle with a good ferrule and an inserted cutter made of thin spring steel. One edge is to be sharpened and that from the inside of the curve, in order to do a neat job of cutting. Having drawn the temper and shaped out the cutting piece, sharpen the edge and bend the cutter around a piece of ¾ in. round rod. Then re-temper and insert in handle. The cutting edge will have to be touched up slightly, for it must be sharp.

In cutting the index marks, open the book to the place wanted and insert heavy fiber paper to cut on. Slope the edge of the book so that when you cut through the pages by means of light blows of the hand on the handle, you cut vertically. When you index your book, cut the marks so that they all face toward the front of the book.



DETAILS OF PUNCH

EDITORIALS

The Metric Bill Once More

HEARINGS have been held in Washington by Senator McNary on Senator Ladd's bill to make the metric system compulsory after ten years. Pro- and anti-metric enthusiasts are going through once again the arguments for and against this system of measurements which commends itself to many by reason of its decimal divisions.

As we see it, little can be added either way to what has already been said regarding the merits of the metric system. What the Senate committee must decide is whether or not it is possible by legislation to force the adoption of a system of weights and measures of which more than nine-tenths of the American people are utterly ignorant. We have seen several attempts to enforce laws and even constitutional amendments passed by reason of the organized activity of a vociferous minority. The result has not been an unqualified success and the expense has been stupendous.

If this bill passes it must overcome not only the passive resistance of the great mass of the people but also a very active organized resistance on the part of those who are bitterly opposed to it. The experience in other countries which have tried to force its adoption by legislation should point a lesson to our own legislators.

One other point deserves mention. Congress has been sitting in special session for some months now to pass vitally important taxation, tariff and transportation bills. So far no results have been obtained worthy of mention. The people of the country are growing restless under the delay and the Congressman with his ear to the ground will hesitate to take time from important business to consider such a doubtful plan as the overturning of our long-established system of weights and measures. It would seem that the metric advocates were ill-advised to push their program at such a time. There are many, however, who will shed no tears if the Ladd bill dies in committee.

Is Your Coal In?

SOME weeks ago we recommended to manufacturers the immediate purchase of at least a large part of the winter's coal supply. Later developments indicate clearly that we were right. The man, or the company, who has not three months' supply in his storage pile is quite likely to wish that he had before the winter is over.

The threatened railroad strike, if it is carried through, can make a bad matter very much worse. According to the prophets all signs point to a severe winter. And last but not least, the possibilities of an early and amicable settlement between the coal operators and the miners of the inevitable differences over the new wage schedules, are remote. Next spring both anthracite and bituminous contracts expire together. Is it necessary to say more?

Our purpose in publishing these lines is not to shout, "I told you so," but to urge action if and when the rail strike has passed into history, before another calamity befall.

An Ill-Advised Strike Order

THE universal condemnation of the order to tie up the railroads of the country by a nation-wide strike of the brotherhoods should be food for thought for the men who called it. People have not forgotten how the Adamson law got on the statute books, nor have they forgiven those responsible.

Aside from the merits of the trainmen's case, which are visible to but few outside the union ranks, the wisdom of calling a strike at a time like this is open to grave question. If, as some labor men claim, there is a conspiracy on the part of the railroad executives to crush the unions, then the unions are certainly playing straight into the hands of the enemy by taking a position which alienates public sympathy so effectually.

It is extremely unfortunate that such an attitude exists between the men and the railroads, for it can more than undo all the good that has been accomplished by the efforts of President Harding and Mr. Hoover to bring capital and labor together to discuss the common dangers in the unemployment situation. Not only this, the crippling effect of a transportation tie-up on our slowly reviving business would be a setback that would take months to recover from.

We find it hard to believe that there is not a certain element of bluff in the statements made by both sides. The executives who are talking about a fight to a finish must realize that even if they won such a fight they would not be far from a finish themselves when it was over. Their finances now are in a precarious condition. What would they be after a strike?

On the other hand the labor leaders have admitted that public opinion would be against them. They must know that a strike has never been won permanently in the face of that same public opinion. Add to this the fact that they are striking against a decision of the Railroad Labor Board, the governmental body legally appointed to arbitrate wage controversies, but without power to enforce its decisions, and their situation certainly appears to be most unsound.

As this is written there are rumors that some sort of a settlement is in sight. We sincerely hope that they may be well founded and that before we go to press the strike will have been called off. It will be a dark winter indeed if men do not come to their senses soon.

What Are the Worker's Prospects in the Machinery Building Industry?

UNDER this title we show on another page a set of curves giving wage rates at various ages of boys starting in work in a machine shop and a letter describing them. Two series of curves are included, one for boys with college or technical school educations; one for boys without. The author concludes that, for the average boy, a college education is more of a hindrance than a help as far as earning a living in the shop is concerned. This conclusion is certainly open to question and we hope to hear from those of our readers who have strong opinions on the matter.

Shop Equipment News

"Ohio" Constant-Speed-Drive Milling Machines

The Oesterlein Machine Co., of Cincinnati, Ohio, has recently introduced to the market a complete line of milling machines of the constant-speed-drive or all-geared type. The line consists of No. 1, No. 2, No. 2 heavy, No. 3, No. 3 heavy and No. 4 sizes, each size being made in both plain and universal types. Fig. 1 shows the No. 2 plain machine, and Fig. 2 the No. 3 heavy-duty universal one. The maker states that the fundamental idea underlying the development of the design has been to produce a machine with all of the features essential to modern milling practice, but to secure these features by reducing the number of parts to the minimum and increasing the strength of the necessary parts to the maximum.

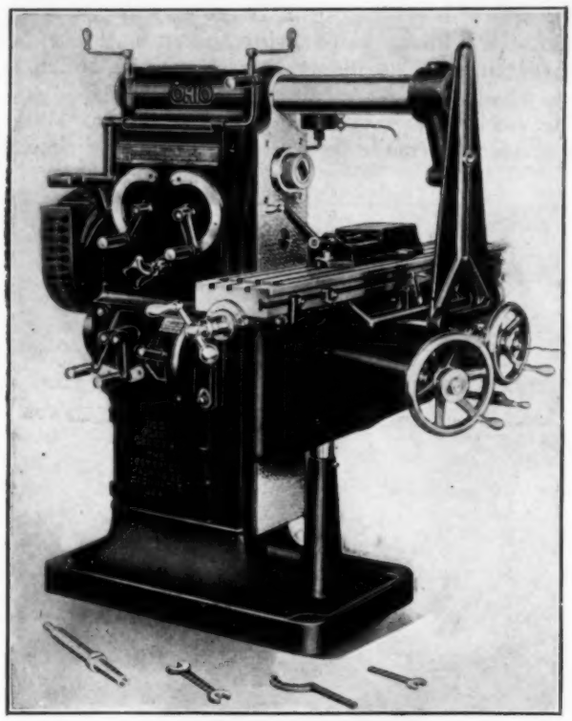


FIG. 1. "OHIO" NO. 2 CONSTANT-SPEED-DRIVE MILLING MACHINE

The speed-change mechanism consists of but fifteen gears, from which sixteen geometrically arranged speeds are obtained. Only one shaft is employed in addition to the spindle and the pulley shaft. In obtaining eight of the spindle speeds, power is transmitted through a three- or four-gear train, but no quadrants or similar mechanisms are employed for any speed. This simplification of the speed mechanism is said to give a low power consumption in the machine. The no-load power loss of a No. 2 machine varies from 0.18 to 0.30 hp. between the extreme spindle speeds of 16 to 384 r.p.m. This power loss is stated to include that in the feed box set at the highest rate of feed, and in the feed mechanism within the knee, and may, therefore, be regarded as practically the entire no-load power loss.

The speed changes are secured by means of two two-position levers and a four-position knob, the latter controlling the selection of four adjacent spindle speeds. All speed changes may be made without stopping the machine. All gears in the machine are made from low-carbon forgings and put through an annealing, carburizing and hardening process that is said to produce a surface so hard that it cannot be filed, and a gear so tough that it cannot be broken with a machinist's hammer. All gears are sandblasted to remove furnace scale.

The automatic lubrication of the machine is effected without pumps or any extra moving parts, employing a system of three reservoirs. The first reservoir is cast in the top of the column beside the overarm. Into this fresh oil is poured. The oil seeps through felt and down tubing both to cavities cast under the main spindle bearings, and to the intermediate shaft bearings and to the driving pulley. Wicks dip into the cavities under the spindle and carry oil to the bearings proper.

It will be seen that only new oil is admitted to the bearings that are heavily loaded. The oil that passes through these bearings collects in the second reservoir below the pulley shaft, where it is distributed to the speed gears and minor bearings by splash lubrication. The overflow from the second reservoir passes to the third reservoir, which is the feed box. The feed-box parts are oiled by splash lubrication.

The capacity of the first reservoir is sufficient to supply the machine for about two months of ordinary service, it is said. Provision is made for correcting

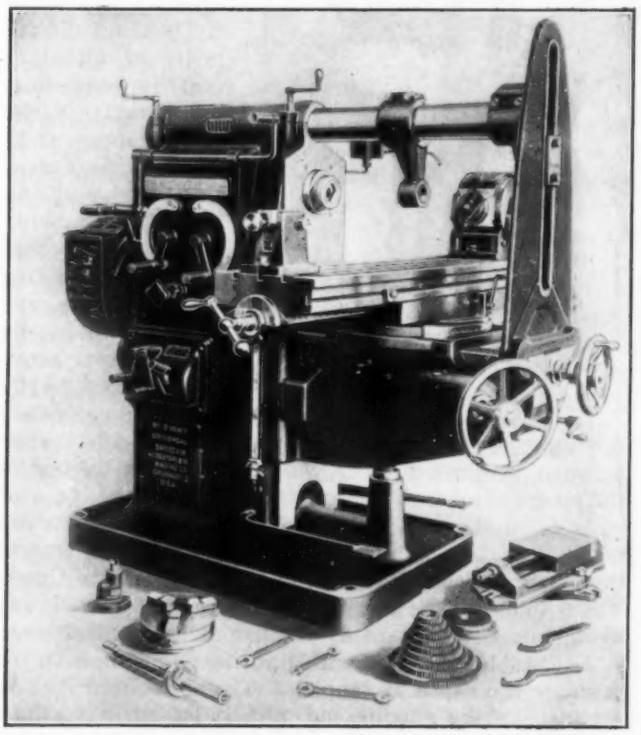


FIG. 2. "OHIO" NO. 3 UNIVERSAL CONSTANT-SPEED-DRIVE MILLING MACHINE

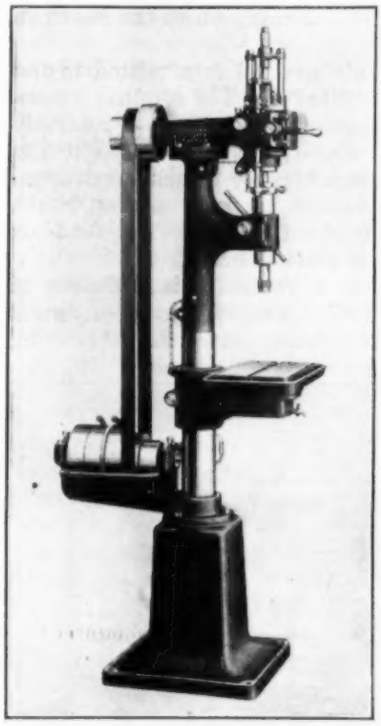
the level of oil in the third reservoir, should this level decrease. This replenishing is accomplished by adding new oil, and is necessary not more than twice a year.

The driving pulleys are 14 in. in diameter and run at 400 revolutions per minute. Use is made of the high belt velocity by controlling the operation of the machine by tight and loose pulleys, thus avoiding the necessity of a clutch. A brake for quick stopping of the spindle is incorporated in the belt shifter in such a way that the belt is partially carried to the loose pulley and the brake applied to the tight pulley by a spring plunger release.

The feed box is driven off the pulley shaft, producing feeds in inches per minute. The feed box, knee and table are similar to the design previously developed by the company and used in its cone-type milling machines. A phosphor bronze of from 28 to 32 points scleroscope hardness is used for all bearings and feed nuts throughout the machine.

Cincinnati Hy-Speed Machine Co. Automatic Tapping Machine

The Cincinnati Hy-Speed Machine Co., Cincinnati, Ohio, has recently developed and placed on the market a line of automatic tapping machines, shown in the accompanying illustration, and sold under the name of "Hy-Speed." Among the features to which the maker calls attention are the patented spindle lead and automatic reversing mechanism. With the use of the spindle-lead device, the tap is brought forward and returned in a positive way, without the necessity of attention from the operator. It is said that the hole is tapped accurately without danger of stripping the thread or breaking the tap. One half turn of the stop plunger at the side of the control handle changes from semi-automatic to fully automatic operation. When set for semi-automatic work, the spindle travels forward, reverses automatically and stops at the end of the return stroke. To start forward again, the operator pulls down the control lever. When set as fully automatic, the stop plunger is withdrawn and the spindle then automatically reverses at each end of its travel. The spindle can be stopped at any point, reversed, and again brought forward by the use of the control lever.



"HY-SPEED" AUTOMATIC TAPPING MACHINE

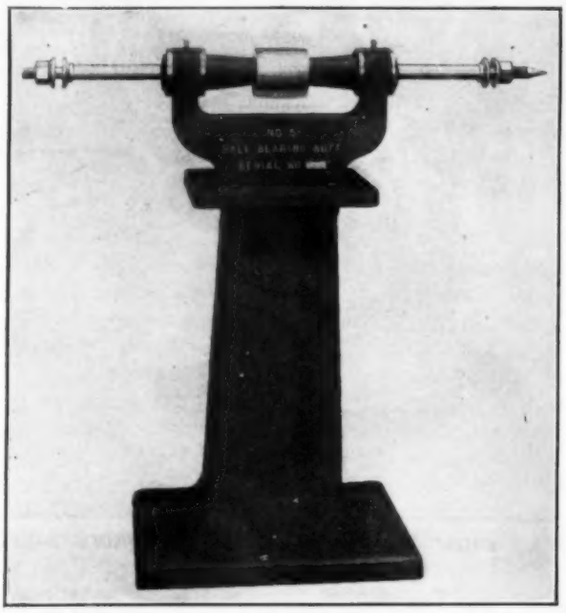
Adjustable trip dogs with limit stops on the trip rod regulate the depth of tapping. The chuck is driven by a clutch on the spindle end, and is locked in position. S. K. F. ball bearings are used throughout the machine. The square table has a T-slot. A coolant pump and tank can be attached to the base.

The machine is regularly made for right-hand tapping; but an attachment can be furnished for left-hand tapping, being fastened to the end of the rack sleeve. The machine is built with from one to three spindles in two sizes, the maxamum capacities being $\frac{1}{2}$ and $\frac{7}{8}$ in., respectively, in steel. The small machine is equipped with tight and loose pulleys, as shown, while the large one has single-pulley drive. In addition to the floor type, the machine is built for bench use, or equipped with belted motor drive.

Blount Ball-Bearing Buffing Machine

The J. G. Blount Co., of Everett, Mass., has just brought out a line of ball-bearing buffing machines, built in three sizes. The illustration shows the No. 5 machine, which is of the medium size.

The machine is very similar to the regular style of buffing machine made by the concern, but is equipped



BLOUNT BALL-BEARING BUFFING MACHINE

with S.K.F. ball bearings in dust-proof mountings. The bearings are secured to the spindle by light drive fits and also by locknuts. The spindle is of high-carbon steel, ground to size, and balanced before fitting to the head. A taper point is fitted to the right-hand end for use with small wheels.

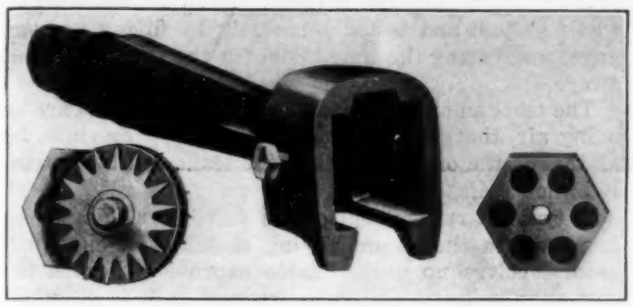
The head is regularly mounted with the pan on the column, the parts being bolted together. The head can be furnished separate for mounting on a bench, if desired. A countershaft may be furnished in either the regular self-oiling type, or with Hyatt roller bearings.

Desmond-Hex Grinding-Wheel Dresser

The Desmond-Stephan Manufacturing Co., Urbana, Ohio, has recently brought out the Desmond-Hex grinding-wheel dresser, the principal feature of which is the fact that it provides a number of interchangeable bearings for the pin carrying the cutters. It is stated that the chief weakness in the type of dresser formerly made, which carried the pin or spindle in hardened steel bushings mounted in the handle, is that the bushings eventually wear and become loose. Although the bushings are replaceable, the holes containing them usually

become large, so that the handle itself must be discarded.

The handle of this dresser, however, is channeled on the inner sides of the head to hold removable, hardened,



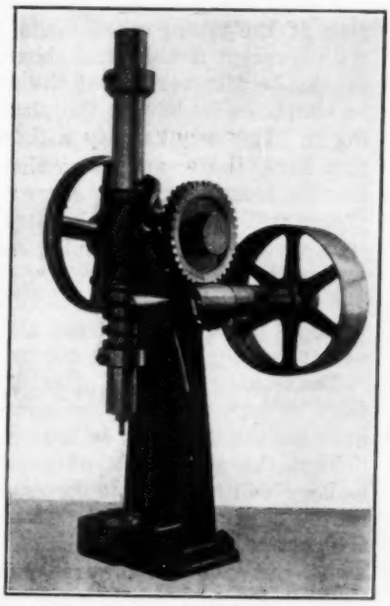
DESMOND-HEX GRINDING-WHEEL DRESSER

hexagon nuts having six holes drilled partially through each. The holes in these nuts serve as bearings for each end of the spindle carrying the cutters, the arrangement being shown in the accompanying illustration. Each nut is held in place by a setscrew from the outside that fits a tapped hole in its center. When the holes in which the spindle is running become worn, the nuts are removed by loosening these screws, and turning the hexagon so that the next pair of holes comes into use, the spindle being placed in them. In this way six pairs of bearings are available with each set of nuts, and the nuts can be replaced when all the holes have become worn.

The dressers are made in two sizes, the No. 1 size taking the ordinary standard cutters 1½ in. in diameter, and the No. 2 size carrying seven cutters 2⅜ in. in diameter and being intended for use on large and coarse wheels.

American Broach and Machine Co. Power Broaching Press

The accompanying illustration shows the power broaching press recently placed on the market by the American Broach and Machine Co., Ann Arbor, Mich. The machine is of the bench type. It is operated by a 2½-in. belt on a 10-in. pulley, the pulley revolving continuously in one direction. The power is transmitted through a worm and worm gear of 30-to-1 speed ratio, and thence through a steel pinion and rack. The ram is 2 in. in diameter with the rack teeth cut directly on the back of it. The worm is arranged to automatically disengage at a predetermined point in the stroke, which point is adjustable by means of a collar at the top of the ram. The return of the ram is effected automatically by means of a weight and cord, the latter being wound in a groove in the periphery of the handwheel. The machine has a stroke of 14 in. The bore in the table is 2½ in. and is central with the ram. The machine is suited for operating push broaches, for pressing mandrels in and out, for pressing in bushings, and for numerous operations often performed by hand.

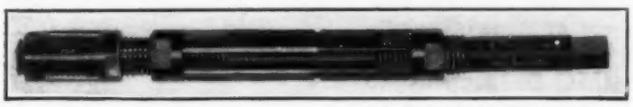


AMERICAN BROACHING PRESS

Critchley Expansion Reamer with Adjustable Pilot

Chadwick & Trefethen, 32 Bow St., Portsmouth, N. H., has recently placed on the market a style of its Critchley expansion aligning reamer, especially adapted to the reaming of piston-pin holes in automotive-engine pistons when making repairs that involve oversize pins.

In addition to the six blades usual to this type of reamer, the tool carries upon an extension of the body three shoes of such shape that they slide in the same grooves as the blades, although their combined surfaces cover nearly the complete circumference. The shoes form a substantial pilot to center and align the reamer when entering the hole to be reamed. The ends of each shoe are beveled to fit the concaved adjusting nuts used to confine the blades. By moving these nuts, the size



CRITCHLEY EXPANSION PISTON REAMER

of the pilot may be increased or diminished to suit the hole to be reamed.

In addition to the pilot, the upper third of the cutting blades is ground to a true circle of a size to just fill the newly reamed hole, thus providing a bearing both before and behind the cutting blades. The reamer is made in ten sizes ranging from a minimum of $\frac{13}{32}$ in. to a maximum of $\frac{11}{16}$ in., each reamer expanding $\frac{1}{16}$ in. All parts are made to gage.

American Goods Held in Argentina

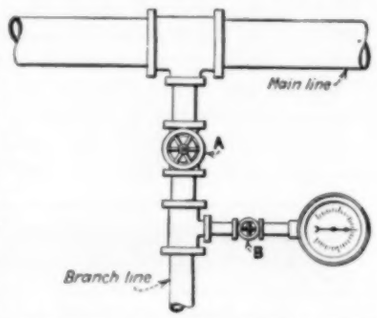
The inventory of the commodities and the value of merchandise held in the customhouse in Buenos Aires, which Commercial Attaché Edward F. Feely has been conducting for some time, has finally been completed. The returns of all banks show that the total American collections outstanding on Jan. 1, 1921, amounted at par to 35,000,000 gold pesos, aside from the merchandise covered by New York credit, which was estimated at approximately $10,000,000 United States currency. The total American collections outstanding of all banks was 24,000,000 gold pesos on June 30, while by August it had been reduced to 17,500,000 gold pesos, and had reached 14,000,000 gold pesos on Sept. 30. Liquidation during the months of July, August, and September was made at the average rate of exchange of 147, the current rate Oct. 11 being 133. The invoice value of the refused merchandise amounted on Oct. 1 to 6,250,000 gold pesos (at par) and bankers are generally agreed that a reasonable fall in exchange will eliminate the greater part of this amount. Paper pesos deposited to guarantee accepted drafts are estimated at the equivalent of 8,000,000 gold pesos. A more detailed report of Mr. Feely's investigation has been mailed to the Bureau of Foreign and Domestic Commerce and will be published later.

Care of Compressed Air Lines

By John S. Watts

Probably the greatest loss in efficiency in compressed air systems is due to the loss by leakage at the joints of the piping and at the valves. That this loss is in nearly all cases a serious one, is shown by the fact that the air pressure falls rapidly whenever the compressor stops. In my experience with the average system, the time which elapses from the stopping of the compressor until the air pressure has been completely lost, is seldom over twenty minutes. I have known cases where it has taken the full output of one large compressor to simply keep pressure on the line when no tools were using air.

The locating of leaks in air piping is, owing to their not being visible, a tedious job and unless there is some way of checking up the tightness of small parts of the system individually it is practically impossible to keep an extensive line of piping, with the usual ramifications inherent to the system, in any kind of freedom from leaks. The average practice seems to be for the superintendent or some other official to order any leak that he happens to notice in passing, to be repaired, which is not apt to lead to much in the way of economical results as the smaller leaks usually make the most noise. If a man is apportioned to the work of locating leaks and stopping them, he is very apt to confine his attentions to the main lines, and leave the smaller branch lines, which are really the worst offenders, to their fate as being beyond all redemption.



APPLYING A GAGE WHILE THE PIPES ARE UNDER PRESSURE

Strange as it may seem, there is a widespread belief among the men who run air operated machines that air being free, its waste involves no monetary loss and is therefore of no consequence so long as the pressure is not thereby reduced below that at which the tools will work. This misapprehension tends to make the operators careless about shutting off the air from tools not in use, and about closing valves. It is no uncommon thing to find a valve left wide open after a machine has been disconnected from the line. It would be money well spent to educate the men to an understanding of the cost of an air leak in dollars and cents.

For an executive to make a point of trying to observe the leaks caused by this carelessness and remonstrate with the guilty party seems an obvious duty, but the carelessness is so general that one is apt to form a habit of listening for air leaks until it becomes almost an obsession, and interferes with the carrying out of more important duties.

To attempt to get a check upon the tightness of the system by having a watch kept on the gage on the air receiver gets us nowhere, as the air piping is generally so scattered and tortuous. While the receiver gage tells us the state of the system as a whole, by the rapidity with which it falls when the compressor stops, the total leakage is made up of so many small leaks scattered all over the plant, that one seems never able to get them all stopped, because as fast as we close one leak, another or a dozen more start up somewhere else.

The best system which I have seen so far, and one that does improve matters considerably, is to divide up the piping system into a number of convenient-sized divisions and by inserting valves at the proper points, so arrange it that any one division can be cut off from the whole system and tested separately by fitting pressure gages and noting the time taken for the pressure to leak away.

The test can only be carried out when the tools are not using air, that is at the end of each working shift, but as that is the only time when the leaks can be repaired it is not a disadvantage.

A typical arrangement of the valves for this purpose is shown in the accompanying sketch, and as will be seen, involves no unreasonable expense either in first cost or in upkeep. Only one pressure gage is necessary, as it can be put on and removed with the pressure on the line by the closing of the valve *B*, shown in the illustration, thus allowing the gage to be transferred to any division that it is desired to test. To make the test, the valve *A* is closed while the full pressure is still on the line and after screwing the pressure gage into place, valve *B* is opened. The branch line under test being now isolated from the main line, the gage will show how long the pressure takes to fall from 80 to 60 lb. and the leaks on the smaller length of piping being tested can be readily located. This test should be repeated on each division until the time that elapses in falling the 20 lb. has reached a set minimum, when another division can be taken in hand.

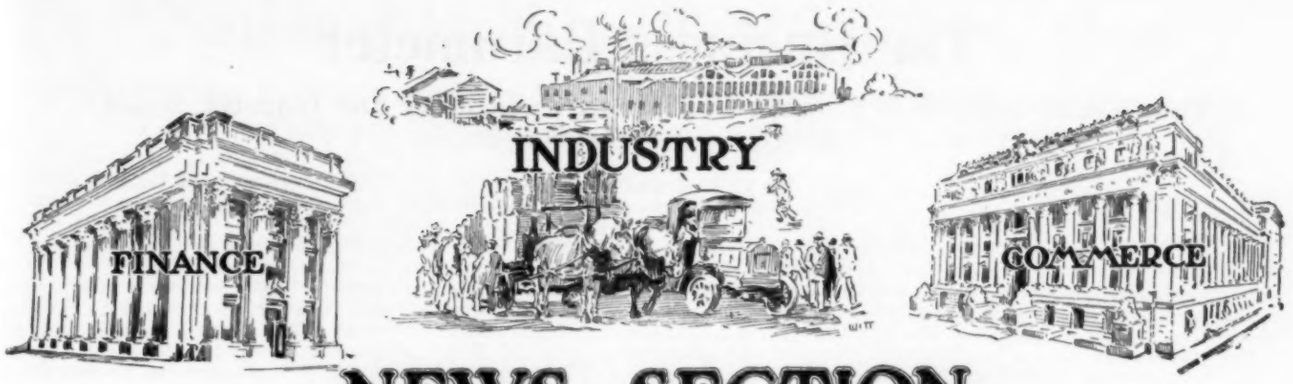
The method used is first to find which are the most leaky divisions and after they have been brought to a fair state of air tightness, have the mechanic in charge of this work make periodical tests of all the divisions in rotation and keep them all up to the standard determined.

The main advantage of this method is that it gives immediate results as the pipes being tested can be brought down to a length that can be gone over thoroughly, and the leaks located and stopped. The progress made is ascertainable and gives some encouragement to persevere, much more so than when the test is run on a system as a whole where the leaks are so numerous that one becomes discouraged before the results of the work will show.

Almost every system would be much improved if a plan of the piping were made and no new piping installed, except it were first shown on this plan, as it will usually be discovered that the proposed new piping can be simplified by having the plan before one when locating it. The very facility with which air piping can be run, here, there, and everywhere, has tended to make trouble from leaks. A survey of any old system of piping will show, if no plan has been followed, that we soon have a mess of air piping running all over the place, a part of which is as sure to be as leaky as the proverbial sieve. It is very rare to find an old branch removed when its usefulness is ended, although it would certainly pay to cut out all piping not in use.

The making of a plan of existing piping will generally show a lot of pipes that can be eliminated, and so decrease the loss from leakage quite appreciably.

That the attainment of a reasonable freedom from leakage will well repay the expense of getting it need hardly be emphasized, as this leakage involves not only the cost of compressing the air that is allowed to leak away, but also the lowered efficiency of the air tools through low air pressure and the probability of having to purchase larger or more compressors than required.



NEWS SECTION

Program of Industrial Cost Conference

The tentative program of the second national cost conference of the Industrial Cost Association, which will be held at Pittsburgh, Pa., on Nov. 2, 3 and 4, has been announced by the secretary Albert A. Alles, Jr. A comprehensive program covering costs and profits, sales, accounting, inventories and general business conditions has been prepared. It is expected that Secretary of Labor Davis will attend the banquet on the evening of Nov. 3. The program so far arranged is as follows: "Sanitation and Safety," by J. B. Ayres, National Tube Co.; "Costs and Profits of Welfare, Sanitation and Safety," by Major William Hogg, National Tube Co.; "Responsibility of the Comptroller or Accountant in Times of Business Depression," by F. S. Willett, Dodge Manufacturing Co.; "What the Sales Manager Should Have From the Accounting Department," by S. B. Taylor, S.K.F. Industries, Inc.; "How Can a Cost System, Although Efficient, Demoralize an Organization," by J. M. Howell, General Electric Co.; "Inventories — Methods of Completing the Physical Count," by E. C. Grimley.

At the banquet the speakers will be as follows: "Looking Into the Future," by Newcomb Carlton, Western Union Telegraph Co.; "Federal Taxation," by Sanford Robinson of New York, N. Y.

Dr. King Re-Appointed Cuban Consul at Atlanta

The Cuban government has again appointed Dr. Guy King as Cuban consul in Atlanta, this being his ninth successive year in that capacity. Since Dr. King became the Cuban consul in Atlanta export trade between that city and the island has developed to more than $1,000,000 per year. Most of Atlanta's export trade with Cuba includes machinery and mill supplies, machine tools and equipment, railroad supplies and equipment, and metal products of various kinds.

Automobiles in Samoa

Vice Consul Quincy F. Robins, at Apia, writes that there are probably 125 automobiles and trucks in Western Samoa, the majority being small cars. The mileage of tires is very low on account of bad roads and the destructive climate.

Ordnance Dept. Proves Efficient at Aberdeen Tests

Ordnance officers believe that the recent elaborate tests at the Aberdeen Proving Ground gave them an opportunity to prove that their engineering is sound and that the Department is doing efficient, forward looking work. So far as the mechanical features of the test were concerned, the rating was close to 100 per cent. This is held to be the more remarkable since work is based on a 1.2 factor of safety.

The exacting tests to which the two new 16-in. guns were subjected failed to develop any mechanical imperfections of moment. This applies to the 16-in. gun on a Barbette carriage as well as to the one on a disappearing carriage. The tests emphasized the advantages of the Barbette type of carriage. This is due largely to the absolute necessity of a high angle of elevation for long ranges.

Only One Defect

The only mechanical difficulty which developed was with the throttling bars in the hydraulic cylinders which control recoil. It is admitted that there must be some improvement in the design of these parts. Another weak point was in the elevating screws. To prevent excessive breakage of these parts, hydraulic cylinders have been placed at the base of the elevating arms. It was stated that this device is in need of some perfecting.

The mechanical engineers have been somewhat apprehensive of trouble with the drop-blocks on the Barbette carriage because of the multiplicity of threads which complicated the method of obturation.

There was not a single failure in any test to which the mechanical features of bombs were subjected.

One of the striking demonstrations of the test was the performance of the mobile 8-in. gun. It was shown that this very heavy piece of artillery can be moved with a speed sufficient to keep up with the army at any time. While it is admitted that there is still much to be desired in the way of mechanical improvements of track laying vehicles, it was shown that high speed can be maintained with much less power than formerly was required and that the track mechanism possesses sufficient length of life to make it thoroughly practicable. It also was shown that much has been done to reduce the noise on vehicles of this type, an important factor in wartime operations.

Metal Trades in Conference at Dallas

The western division of the Southern Metal Trades Association held an important meeting at Dallas, Tex., Oct. 12 to 14, in conjunction with a meeting at the same time of the Texas Industrial Congress. J. H. Dore, of the Houston Car Wheel and Machine Co., Houston, Tex., first vice-president of the association, presided. An address on the progress of the open shop in the foundries and shops of the South was delivered by L. J. Black, of Beaumont, Tex. W. C. Trout, of the Lufkin Foundry and Machine Co., Lufkin, Tex., vice-president of the association for Texas, spoke on "How Present Wage Scales Effect Business and How They May Be Equalized." The association's foundry cost system was explained by Mr. Dore and W. E. Dunn, Jr., of Atlanta, secretary of the S. M. T. A. This system is for machine shops and foundries.

Subjects discussed in open forum included freight rates in their relation to the metal trades industries of the South, the adjustment of wage scales in railroad shops, and whether or not effort should be made to secure pig iron contracts that are not all one-sided.

Pierce-Arrow Sales Approach Normal

Production and sales activities of the Pierce-Arrow Motor Car Co. of Buffalo, N. Y., which have been accelerating gradually during the last three months, have reached a schedule which is rapidly approaching normal. As a result, the factory is running full time with a force of 4,230 workers. There is every prospect, according to company officials, that this force will be maintained, if not increased, during the next six months.

"Insofar as the automobile industry reflects general conditions throughout the country, our situation indicates a decided improvement in business," said Colonel Charles Clifton, chairman of the board of directors of the company.

"The unfilled orders we have on hand will keep the plant operating at its regular output until Dec. 1.

"These orders are not the result of a sudden or freakish flare-up of business. They represent a healthy, day-by-day increase, which shows no sign of letting up. Indeed we are confident that Jan. 1, 1922, will find the company with sufficient orders to operate from sixty to ninety days ahead, which is the basis on which we plan in normal times."

The Business Barometer

This Week's Outlook in Commerce, Finance, Agriculture and Industry Based on Current Developments

By THEODORE H. PRICE
Editor, *Commerce and Finance*, New York

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The possibility of a railway strike has overshadowed other happenings of the week to such an extent that nearly all the market news must be discussed in the light of the strike's connection with it. The securities markets during the week have been merely barometers of opinion, reflecting by their fluctuations what people think as to the likelihood of a walkout and its effect.

It is therefore encouraging to note that the quick recovery from the early decline in stock prices supports the conclusion which one must reach after an independent survey of the probabilities; namely, that the folly of such a strike and the certainty of its defeat are so apparent even to the labor leaders that their threat will never be made effective. Nevertheless it is reported that in commodities such as textiles, whose distribution would receive a serious check from such a catastrophe, purchasers have shown a hesitation which has brought back the era of hand to mouth buying and temporarily curtailed market activity.

It is more profitable to realize that the effects of such a strike on business would be minimized by its probable incompleteness and short duration than it is to debate whether it will occur. Potentially its capacity to disrupt the nation's economic life borders on the infinite, but practically there are many reasons why it would soon collapse, including the almost certain refusal of the less important unions to join the brotherhoods, the announced intention of the Government to run mail trains, the determination of the railroad executives to "have it out" and their preparedness for a struggle, the almost universal condemnation which the threat has received from public opinion, and the earnest efforts at compromise which are being made as this is written. As a business factor I think that the markets have gaged it accurately—a cause for hesitation only where hesitation can involve no loss.

It is becoming increasingly evident that the stock market cannot long be held down by pointing to wreckage which has drifted ashore from the past and is all but cleared from the stream. Oil shares responded promptly last week to the steadily increasing strength of the petroleum market and to the fifth advance in a month in Pennsylvania crude. New financing has been well taken and bonds are firm. Improved earning prospects are reported from nearly all the leading industrial corporations and since most bankers are predicting that money will become still easier as the crop movement nears completion the beginnings of a primary bull market will probably be in evidence when the weight of the strike is lifted.

The Federal Reserve System's reserve ratio of 70.3 per cent is much the highest of the year and both rediscount and reserve note circulation are the lowest since the armistice. Talk of another cut in rediscount rates is persistent. The gain in gold holdings of the system reaches the astonishing total of $44,000,000, and the efforts of other nations to refill their money bags at our treasure house are redoubling. Peru, Chile, Argentina, Cuba and Mexico are all active candidates for loans in this market and in the case of Cuba the announcement of a $50,000,000 credit is to be momentarily expected. Otherwise efforts to help our foreign trade are still unproductive and reports of the outlook ahead of it still lugubriously stress the demoralization of the exchanges and the alleged truth that Europe is consuming only 30 per cent of the goods she used in pre-war days. But the fact is that despite the difficulties in the way of buying the rest of the world must have goods and we are doing a much larger volume of overseas business, mainly in foods and raw materials, than those who fail to take proper account of the price decline believe. Out of twenty articles listed among our September exports seventeen, and the most important ones, were shipped abroad in much greater quantity than in September a year ago, and the total volume was roughly equal to August.

American Optimism

Under such circumstances it is not surprising that we are still prosperous despite foreign troubles. There is a grain of truth in the pratings of those who say we cannot expect complete recovery until we recognize the government of Mexico and until the Central Powers and Russia are again drawn into the world's organization, nevertheless for cripples we are hopping into our automobiles and Pullmans and walking into the dining rooms of expensive hotels with amazing celerity.

The state of the world abroad advanced more than it receded during the week. The betterment of British Indian export trade has actually drawn, for the first time in many months, an export shipment of gold from this country to India, normally a great absorber of the world's gold. Silver made a new high for the current movement of 73⅝ cents, connoting better times for Far Eastern trade. Sterling exchange has crossed $3.95 for the first time in five months and other Western European currencies have been strong, while even the mark recovered to 68 cents per hundred from its low of 52½. In New York the feeling seems to be gaining ground that the mark has passed its low point, and South America is buying actively, but as it is already irredeemable and the financial difficulties of the German government are already so obviously insurmountable that it is on the point of falling, I am inclined to think that the printing presses will continue to augment the supply for some time to come. Last week they added more than a quarter of a billion to the circulation. The frantic rush to get rid of marks continues throughout Germany and no thoughtful person dares predict when it will end.

Ratification of the peace treaties with the Central Powers is probably the best thing that could have been done under the circumstances and negotiations of commercial treaties providing for exchange of consular officers will follow. In Mexico the settlement of the oil tax controversy and the rise in the price of silver has greatly stimulated business, and oil exports in September were not far below the record. In Great Britain Lloyd George's proposal to stimulate trade by guaranteeing interest on loans has heartened business and even in Russia a "boom" is reported to have followed the practical establishment of free domestic trade.

In this country sentiment is still cheerful, though the fall in wheat and the possibility that it will drop to a dollar is a cause of anxiety because of the impairment of the farmer's purchasing power. The decline offers interesting proof of the futility of the Emergency Tariff to help the farmer, yet the House has passed a bill extending its life until Feb. 1. Coffee, sugar and cotton are also lower and it is not to be expected that the public will support speculative markets until Congress shows more readiness and ability to deal with the problems confronting business. The decline in the cost of living and wage reductions seem to be going hand in hand but the maintenance of high rents, and even the increase in many places, is justly discontenting labor and constitutes a principal obstacle to orderly readjustment. Building is remarkably active for this season and the materials markets are busy. The iron and steel trade is holding its gains but copper interest has waned again. Shoe manufacturers are working near their normal rate and an autumn survey of the tire industry indicates a strikingly improved inventory position. Crude rubber is higher. Mail order houses are doing a better and bigger business.

One result of the depression of the past year is the enormous amount of study which has been given to business problems. Industrial engineers and economists have added so extensively to their knowledge of the causes of these cyclical reactions that they generally concede the possibility of preventing them, or at least mitigating their severity. I have long contended that their causes are human and therefore eradicable and that our fatalistic habit of accepting instead of challenging them is largely responsible for their existence. If others reach this same conclusion in their own way this may be, as I hope, the last time we have to crawl out of such a bog of depression.

National Machine Tool Builders Meet

Annual Meeting in New York Very Well Attended—Statistics and Economic Questions Principal Topics of Discussion—General Outlook Better

The Annual Meeting of the National Machine Tool Builders' Association was held at the Hotel Astor in New York City on Oct. 18, 19 and 20. The dull times seemed to have no effect on the attendance, which was larger than usual. The meeting opened Tuesday morning with the announcement of the convention committees by President August H. Tuechter.

The next order of business was the president's report which was received by the members with close attention. Mr. Tuechter told of the hard times through which the industry is passing and said that the association figures showed that the depression was the worst since 1893, and in proportion to the capacity of the plants the worst ever experienced. Mr. Tuechter then read extracts from the addresses of the various presidents of the association from 1904 up until 1920 and traced through the tenor of the remarks made by each, the rise and fall of the business cycle curve of the machine-tool industry. The president wound up this section of his report with a strong plea for better co-operation on the part of the members in supplying the production and other statistics needed by the general manager to prepare the barometric charts showing industrial trends.

The general manager's office had prepared several charts to illustrate the points made by Mr. Tuechter.

Mr. Tuechter then referred to the report of the Federated American Engineering Societies' Committee on "Elimination of Waste in Industry" and told of the part played by the association and some of the members in securing some of the necessary data for the report. He called attention to the fact that the committee found a high percentage of waste chargeable to the inefficiencies of management and urged the members to give close attention to their own affairs to remedy this situation if they found it existing in their own plants. Mr. Tuechter then went back into the recent history of the association and told of the reasons for the decision to retain a paid executive to handle the association matters and went into some detail as to the budget and means of paying for the services of the secretary and the gathering of the desired statistics. He next pointed out the value of machine-tool figures to other industries, inasmuch as a falling off in orders for machine tools had practically always indicated an industrial depression. As a consequence, complete machine-tool figures would form an excellent barometer to indicate coming downward movements in the general business curve. These could well be exchanged for figures from some of the other industries which occupied the opposite position, that is, whose figures indicated in advance coming rises in the business curve.

ERNEST F. DUBRUL
General Manager

The matter of standardization of machine-tool parts was then taken up and an account of the activities of the standards committee was given. For several reasons, notable among which was the desire of the machine-tool section of the American Society of Mechanical Engineers for co-operation, this committee had held in abeyance most of its plans until the engineers were ready to go ahead. Mr. Tuechter recommended a general committee on standardization to act for the association and special committees to act for the various groups. He gave unstinted praise for the work done by the general manager of the association, Ernest F. DuBrul, and also paid his compliments to the ex-presidents, members of the executive committee, the members of the manager's staff, etc. He concluded his address with some remarks about the probable future of the machine-tool industry and touched on the problem of its vastly increased capacity, the number of second-hand tools on the market, and the desirability of a better knowledge of costs on which to base fair selling prices.

An abstract of the treasurer's report was presented by Winslow S. Blanchard.

The next order of business was the general manager's report by E. F. DuBrul, who gave it as his opinion that the association had in the past been a great power for the stimulation of good fellowship and confidence among the members and that its activities along these lines should be maintained. At the same time there are many legitimate activities of trade associations which have hardly been touched upon and they should be given attention if the association is to serve its full purpose. The trade association is strictly a business proposition and properly conducted can be made to pay well for the time and effort put into it by the various members.

Mr. DuBrul went on to say that matters are in such a serious condition now that this is no time to potter around. On the contrary, the hardest kind of thinking along economic lines is necessary if the machine-tool manufacturers are to get over their present troubles. He also made a strong plea for better co-operation from the members in supplying the data for statistics and charts on production, costs, etc., and said that while present figures were better than none they were hopelessly incomplete and should be largely increased. He pointed out that an excellent barometer would be possible at a very small cost when all the members were ready to give their full co-operation in supplying the figures to his office. He concluded his report with suggestions that a subject worthy of studying was the

Officers Elected by National Machine Tool Builders' Association

AUGUST H. TUECHTER, President; E. J. KEARNEY, 1st vice-president; C. WOOD WALTER, 2nd vice-president; H. W. DUNBAR, Secretary. (We regret that we are unable to present a likeness of Winslow Blanchard, who was elected treasurer.)

relative value of cheap and expensive machines as indicating trends. He said that the few figures in the possession of the association indicated that small tool sales dropped off after those of larger tools, and picked up sooner on the other side of the curve, so that large tool sales could be used as an indicator of depression and small tool sales for evidences of revival.

The afternoon session of the first day was given over to addresses and discussion. The Hon. Charles L. Underhill, Congressman from Massachusetts, spoke in favor of a sales tax. He stated that the excess profits tax has been found to be a failure both in England and in the United States, including reference to the amount of effort required by business concerns to make out proper tax returns.

Business Cycles

The subject of business cycles was admirably discussed by Professor David F. Jordan of New York University. He dealt with the causes for the fluctuations in business conditions, considering the subject under six major classifications — production, marketing, labor, business profits, exchange transactions and finance. Agricultural production has the greatest effect on business conditions, but is a factor which cannot be regulated, principally because it depends upon climatic conditions.

When attempting to prognosticate conditions, it is necessary to take into consideration all of the factors entering into the case, and to determine just which ones are the causes and which the effects. It was Professor Jordan's opinion that the period of liquidation is not yet finished, although recovery will be rapid, and during the coming winter we should witness a marked revival of business.

C. L. Cameron, of Gould & Eberhardt, and Ernest F. DuBrul engaged in a discussion on the subject, "What Things Should Machine Tool Builders Do and What Should They Avoid at Various Stages of the Cycle?"

Mr. Cameron divided the business cycle into four phases: Prosperity, liquidation, readjustment and improvement. He advised a continued effort to determine the causes of depression and showed that one of the difficulties encountered by the machine-tool builders in their attempts to look ahead is the fact that many of their sales are arranged on long time deliveries. He gave it as his opinion that business in general is on the increase, is, in fact, entering the phase of "improvement," but that machine-tool builders are to experience further liquidation.

DuBrul's Analysis

Mr. DuBrul chose to divide the business cycle into six phases: Depression, revival, prosperity, boom, crisis and liquidation. In general, he advised that a careful watch be kept on the relation of production and shipment. He stated that the fore-handed man will, during a period of depression, or at any rate during the latter part of it, stock up just as far as justified by demand, will repair, redesign, systematize, improve his personnel and conduct missionary work.

The revival phase was considered to be a period during which stock should be accumulated. It was suggested that in order to take advantage of the prosperity phase prices should be more sensitive to conditions than they now are. Orders should not be taken during this phase at low prices for long delivery. Liquidation should be begun, but at increased price. The speaker advised that during the boom phase, it is unwise to build a new plant or to book orders too far ahead. It is advisable to sail close to the wind, keeping open the chance to curtail production, to watch out for cancellation, and to pay off debts.

The crisis phase represents the time during which production must be restricted to the point where it is following demand on down. High wages should not be maintaincd. Over-stocking must be guarded against. The phase of liquidation represents the time when it is necessary to sell and when a close watch upon price is equally necessary. The foregoing statements, of course, refer to normal times and it was admitted that prediction is now very difficult on account of the questionable influence of war machines.

Wednesday was devoted to committee meetings, as well as to group meetings for manufacturers of different types of machine tools. At these meetings points relating to the development of the particular line of the industry involved were given consideration, and the idea of developing a statistical service in each line was discussed.

Rastall on Exports

Thursday morning opened with an executive session. The first address was given by W. H. Rastall, chief of the Industrial Machinery Division, United States Department of Commerce, his subject being "The Orient as a Machine Tool Market." The growth of the Asiatic trade in machine tools is indeed surprising. In 1910 our exports of machinery to Asia amounted to only $100,000, in 1915, $500,000, but in 1919, $8,000,000, while 1921 will probably be about $6,000,000. Mr. Rastall stated that the development of Asia will be of more importance from the machine-tool standpoint than that of Latin America. At the present time, about 25 per cent of the total export of American machine tools goes to Asia. India is now being industrialized, providing there a great opening for American machine tools. It was Mr. Rastall's opinion that there would be a great future for American machine tools in the Orient if we would use intelligent salesmanship, and endeavor to give real service to the buyer in the East.

H. L. Flather, treasurer, Flather & Co., Inc., discussed the possibility of utilizing machine-tool plants during slack times. He stated that the company which he represented had tried many make-shifts during times of depression in the machine-tool industry, but he believed that most of the ventures into fields foreign to those normally occupied were unprofitable in the end. He believed that a concern should not attempt to make temporarily a product differing very much from its standard product.

The possibilities of reduction in the cost of machine tools in 1922 was the subject of a talk by E. M. Brotherhood, vice-president, Manning, Maxwell & Moore, Inc. Mr. Brotherhood stated that it was practically impossible to forecast the future in this respect, and that at best only a guess could be made. However, many machine tools are being now actually sold below cost, and it is hardly possible that a normal basis will be reached in 1922.

Foreign Credits

The afternoon session was opened by J. E. Andress, secretary, Barnes Drill Co., his subject being the granting of long-term credit with proper guarantees or insurance in foreign trade. He stated that since some foreign countries are at present extending credit for 120 to 180 days, the American manufacturer must take some steps to meet the situation. He believed that it was not properly a government function to itself handle this matter, although governmental foreign credit insurance has been used in Europe for some time. A co-operative plan for credit responsibility has been developing in this country, and is working satisfactorily as a private enterprise.

Americans Poor Merchants

J. H. Drury, treasurer, Union Twist Drill Co., who has recently returned from a visit to Europe, told of conditions there as related to the machine-tool industry. His opening statement was: "You Americans are all right as manufacturers, but very poor merchants." Due to the fact that so many cheap German machine tools are now flooding the European market, the status of the American machine tool abroad is being greatly injured. Mr. Drury asked that great consideration be given by American manufacturers to their foreign representatives, so as to aid them in every way possible to weather this crisis.

It was decided to hold the next Spring Convention at Atlantic City.

The officers elected were as follows: President, August H. Teuchter, president, Cincinnati Bickford Tool Co.; first vice-president, E. J. Kearney, president, Kearney and Trecker Corporation; second vice-president, C. Wood Walter, vice-president and secretary, Cincinnati Milling Machine Co.; treasurer, Winslow Blanchard, president, Blanchard Machine Co.; secretary, H. W. Dunbar, sales manager, the Norton Company. Ernest F. DuBrul will continue as general manager of the association.

Government Cuts Ordinary Expenses in September

Ordinary expenditures of the Government fell off by almost $25,000,000 during September, as compared with August, according to the monthly statement issued on Oct. 18 by the Treasury, while payments on the public debt increased by more than $800,000,000.

During September ordinary expenditures totaled $266,523,392, as against $291,157,847 in August, while public debt disbursements aggregated $1,173,842,743, compared with $237,519,233 in the previous month. Redemption of certificates of indebtedness amounting to $1,051,903,950 accounted for the bulk of the public debt disbursements.

Fall Meeting of Machine-Tool Section of National Supply and Machinery Dealers' Association

The Machine Tool Section of the National Supply and Machinery Dealers' Association held its fall meeting at the Hotel Astor, New York City, on Wednesday, Oct. 19. The meeting was opened by the chairman, L. H. Swind, of the Swind Machinery Co., Philadelphia, Pa., whose address dealt broadly with conditions in the industry and with the work of the association.

Mr. Swind stated that close co-operation was necessary between the buyers and sellers of machine tools at this time, because of the fact that as a rule the buyers do not have the cash resources necessary. Credits must be extended in some manner, so as to alleviate the conditions. Mr. Swind said that the problem of selling machine tools has been greatly complicated by the presence of so many rebuilt and second-hand machine tools on the market. Since it is necessary that these tools be absorbed, he advocated an appraisal plan, so that the true value of the tools could be determined and guaranteed to the customer. Considerable attention was given by Mr. Swind to the subject of taxation of machine-tool dealers.

Mr. Swind stated that it was a matter of common knowledge to the industry that the present and immediate future did not offer any great amount of encouragement. It was his belief that for the resumption of business we must look to the railroads to take the initiative. In closing, Mr. Swind stated that the present time offers a great opportunity for the development of real salesmanship in machine-tool fields.

August H. Tuechter, president of the National Machine Tool Builders' Association, spoke on the need of close co-operation between the machine-tool builder and the machine-tool dealer. He stated that the dealer is in this case not the market of the builder, but rather the channel to the market. Since he considered that the dealer represented merely an extension of the sales force of the builder, dealings should be characterized by all the honesty and frankness possible.

M. A. Viall, Brown & Sharpe Manufacturing Company, as he himself stated, was both optimistic and pessimistic in his viewpoint. He spoke on the economic conditions in the machine-tool business at present. He has faith in the future of the industry, because of the fact that its market continually changes, having been kept busy in the past successively by the sewing machine, the bicycle, the automobile and the electrical industries.

E. J. Kearney, Kearney & Trecker Corporation, gave it as his opinion that there is no need at present for making special concessions to educational institutions supported by taxation, when selling them machine tools for use in industrial training.

Percy M. Brotherhood, first vice-president of Manning, Maxwell & Moore, Inc., in his address stated that it was necessary that a certain percentage of a dealer's resources should be kept liquid in order to constructively finance sales promotion during periods of low business, although the amount would vary in each particular case.

H. K. Mitchell, president of the Harron, Rickard & McCone Co., San Francisco, Cal., brought a very optimistic message from the Pacific Coast. He stated that the business there seems to be about 60 per cent of the 1920 business, most of it being done with small concerns.

The afternoon session was devoted to the consideration of many questions vital to dealers in machine tools. The effect of the presence of so many old and second-hand machines on the market was discussed at considerable length. The price of second-hand machinery was stated to be about the same as the price of new machinery in 1914. Many of the machines on the market at this time are coming from export dealers, and from the government stores, and are new, or practically so; but in order that the tools may be unloaded, they are often sold at the price of second-hand machines.

The section decided to co-operate as far as possible with all national organizations touching its field, particularly the National Machine Tool Builders' Association. The question of advance information on machine tool prices was given attention, and although very desirable from the dealers' standpoint, was considered to be difficult of attainment.

Progress of the Hearing on Ladd Metric Bill

After listening to a large number of witnesses, who favor Senator Ladd's bill proposing the compulsory adoption of the metric system as a single standard of weights and measures after ten years, Senator McNary, of Oregon, who is conducting the hearings, expressses .himself as being convinced that the principle of the metric system is right, but states that he doubts the advisability of forcing it upon the people by law. From the excerpts of testimony and comment which follow, an idea may be obtained of the character of the hearing.

In the course of his testimony before the committee, Dr. William J. Schieffelin, a chemist of New York, said: "It was in Munich that I became entirely accustomed to the use of the metric system, although, of course, in the laboratory at Columbia we used it. In Munich everyone used it. I lived there a year and a half and when I came back to the United States I was really shocked to find the complication and the delay not only in business but in ordinary life that this present lack of system entails upon us. It is a greater handicap than any of us appreciate."

Senator Jones at one point in the hearing said: "Personally I am convinced that it would be better for this country if we had the metric system. What I would like to know is how we could bring it into existence without making too abrupt a change."

Extracts from the testimony of Elwood Haynes, president of the Haynes Automobile Co., of Kokomo, Indiana, are as follows: "There is no reason why we cannot take a lathe, for example, and turn to the metric system size whenever we are disposed to do it. We do not have to throw away all of the machinery. That is true of a large number of machines. Jigs and taps, for instance wear out anyhow and have to be bushed or something done to keep them standardized. Nearly all research work is done in the metric system. Our industries are dependent upon the research work of our scientists. They work in the metric system because it is simple, more logical and can be handled with much greater facility. When the scientist is called on to make any investigation, he makes it in the metric system. Then he is obliged to transform his figures into the common system which is a laborious and cumbersome process.

"I favor very decidedly the adoption of the metric system. I think this bill is quite practical. Of course, I should want to give the matter some study before I gave an opinion of it."

During the testimony of Arthur B. Smith, chief research engineer of the Automatic Electric Co., Chicago, Ill., the following colloquy took place between Senator McNary, chairman of the Committee, and Mr. Smith:

Senator McNary: "As a practical question, do you think the Government should impose this system upon the people by statutory enactment, setting an arbitrary date, or should it be brought about through a gradual approach, being taught in the schools to the young and being adopted by those who believe in the system?"

Mr. Smith: "I do not know that I am in a position to express myself on that. Our plan is that we are going to go ahead ourselves. It will make it easier for us. It will be of assistance to us and to every other manufacturer who wants to progress, if the rest of the country comes with us."

Senator McNary: "Do you think legislation of this kind is important and is it needed?"

Mr. Smith: "I think the change to the metric system is very greatly needed."

Senator McNary: "Can that be brought about gradually by teaching it in the schools or should be it forced upon the public?"

Mr. Smith: "We have had a lot of other things forced on us and I am inclined to think that inasmuch as we are law abiding citizens, we will all fall in line and obey it."

Senator McNary: "I appreciate that, but it is not at all an answer to my question."

Mr. Smith: "I believe if we leave it to individual initiative, the thing will drag out unduly. I believe we will have to have legislation."

Senator McNary: "Do you think that people who are not engaged in your line of work, people such as the wage earner, the salaried employee, the farmer, would gain anything by the adoption of this method and would yield to it readily and willingly?"

Mr. Smith: "They will gain by it and will yield to it readily."

Senator McNary: "Engineers are a different proposition. Of what advantage is it to the farmer out in North Dakota or to a fruit grower?"

Mr. Smith: "As to the farmer, I am not sufficiently informed. As to the storekeeper and other trades people and ordinary homekeeper, they will benefit greatly by it."

Senator McNary: "I am wondering, as a practical proposition, if the next generation would not accept it better than having it forced by arbitrary legislation upon those people who are out of school."

GROUP PHOTOGRAPH OF DELEGATES AT ROCHESTER MEETING
(The report of this meeting was published

Afterthoughts of the Unemployment Conference

Lack of Fundamentals of Business Economics—Coal Strike Probabilities—Hoover's Closing Remarks

Information laid before the Unemployment Conference indicates that social unrest in the United States is much more widespread than has been realized generally. The men who thus interpret the data, gathered systematically from all parts of the country, are not those who trot out the bogey of Bolshevism. The prevalence of discontent is so widespread that the leaders in the conference agree that fundamental improvement of our social and economic system must begin at once. The fact that there are 4,000,000 men out of employment at this time is referred to as a disgrace of the first order and an outward indication of the need for inaugurating more intelligent economic policies. The recrudescence of coal control bills in Congress is pointed to as an indication of the times.

U. S. Is Individualistic

In that connection it is known that some of the leading figures in the conference cannot disguise their disgust with the frequent demagogic charge that capitalism is the dominant factor in the United States. They point out that the United States is the outstanding example of all history of an individualistic country. Individualism and equality of opportunity are so emphasized that capital really comes in for little public concern. There seems to be no doubt that business as a whole suffers materially because the public is not considerate enough of capital. A fact not fully realized is that the United States is practically the only country in the world in which there is no stratification of classes. In the countries of Europe those in the upper stratum stick there through generations regardless of individual worth. The more meritorious are blocked from displacing the unworthy. Only the most superficial knowledge of social relationships in the United States is necessary to know that class stratification as it exists in Europe could not be transplanted here.

The Unemployment Conference has brought out with particular clearness the great lack of fundamental knowledge necessary to the intelligent conduct of business. Even in dealing with the immediate object of the conference, the whole opportunity of its being helpful has been jeopardized by the lack of real statistics as to unemployment. By a process of elimination, more than anything else, the conference finally established that the unemployed certainly are not in excess of 4,000,000 revealing that business for months has had to withstand the shock and lack of confidence engendered by seemingly authoritative reports of 5,000,000 or more being out of employment.

The Unemployment Conference has not been carried away by the tendency toward centralization. The burden of the solution of the problem of unemployment has been thrown upon the communities. The Federal Government can help but the conference will do all in its power to see to it that Governors of states and Mayors of cities do not pass on unpleasant responsibilities to the Federal Government. State and community officials are being pushed into action and aroused to the necessity of carrying the country through the winter without suffering.

The Control of Labor

The conference necessarily brought up some discussion of employer and employee relationships. Among the thoughts brought forcibly to the attention of the employers was the one that the control of labor by its less intelligent element must be avoided. Particularly favorable mention was made of shop councils. It is stated that there has not been a strike in an industry where shop councils have been established. If they have no benefit other than freeing labor of brutal and unjust foremen, the plan is worth while, it is contended.

From the information available at the Department of Commerce and at the Unemployment Conference, it may be judged that the coal industry is in desperate straits. The importance of coal to all industries makes the attitude of the United Mine Workers of the greatest public interest. It has been revealed during the last few days that efforts have been made by Government officials to insure the country against a coal strike next spring. Since a threatened strike slows down business and has a general upsetting influence months in advance of the possible time of the strike, an effort was made to get the bituminous coal operators and the United Mine Workers to agree in advance to arbitrate any differences that might arise in the Spring. The operators after some hemming and hawing agreed but the representatives of the mine workers not only decline to agree to any such proposal, but tied themselves into a bow knot by voting at Indianapolis to consider no such proposition until February.

Probabilities of a Coal Strike

Many have discounted the probabilities of a coal strike, but the Unemployment Conference was told that the situation is a very serious one. It is made the more serious by the low level of consumers' stocks. The railroads owe more than $100,000,000 for coal already burned. Due to the failure of Congress to pass the funding bill, the railroads are in no position to buy coal to store. Instead of having fifteen days' supply on hand, they should have three months' supply. The members of the conference were urged to use their influence to convince the people that it is a wise public which will lay in three months' supply of coal at this time. At any rate notice has been served on all consumers and the full responsibility of any coal shortage this winter has been placed squarely on their shoulders.

In the discussion of the coal situation, it was a generally held opinion that it is vicious to attempt to build up a daily wage large enough to cover the idle time. If reserves were sequestered in the season of demand to be used to provide for the period of unemployment, there is a feeling that efforts to increase the number of working days would have more encouragement. The plan of laying aside 10 per cent or

OF AMERICAN GEAR MANUFACTURERS' ASSOCIATION, OCT. 13, 14 AND 15
in the Oct. 20 issue of *American Machinist*.)

some other proportion of earnings for hardtimes was described as being simply composite providence.

The work of the conference will be carried on by a standing committee which has power to reconvene the whole body if an emergency arises.

In closing the conference Mr. Hoover said:

"We have, indeed, a great crisis, and the purpose of this conference has been to find a plan by which we can get through this next winter into seas less rough; into areas of greater economic prosperity; into times when our labor will have been re-absorbed into industry. You have laid out a plan. The plan has been willingly accepted by a large section of the country, and you have erected the machinery to pursue that work, and we will see if we cannot get through this crisis without calling on the funds in the public purse for support and subsistence of our unemployed. Whether we can succeed in that will depend greatly upon the co-ordination and co-operation that we can figure from industries and civic bodies of the United States. That this is a problem for voluntary organization is consonant with American spirit and American institutions. If we cannot secure its solution in that direction, we shall have made a distinct step backward in the progress of this country. It is, therefore, vital that you who return for a term to your own sections of the United States should insist, in season and out of season, that this is a problem that rests upon the voluntary and neighborly action of the American people.

"To me the successful consummation of the conference marks a milestone in the progress of social thought. Aside from the pressure of the war, I believe that this is the only conference held in Washington under the auspices of the Government where the ultra extreme in social thought have been brought together, and where the conference has come through for actual constructive results, and parts in good will. We have found it possible to agree upon every major issue; to agree upon the emergency measures that are required —the social background of those measures, and to agree upon the great principles that must be met if we are to have a recuperation of employment and industry. We may have disagreement as to detail. It would be impossible to bring together 60 persons of strength of mind capable of sitting in a conference of this kind without having such minor disagreement. This, however, is the outstanding thing that this conference has proved, that it is possible to bring together 60 people representing every particular avenue of thought in the United States, and have them sit down together and come to a common agreement upon a subject that vitally affects each and every one of them.

"There has been a definite spirit in this conference that, in itself, is an encouragement to every one in the United States. That is that while we have been here dealing with problems of railways, of shops, and of farms, and of instruments of commerce and industry, there has been in the back ground of every person's mind the fact that we were dealing, not with mechanical things, but that we were dealing with the problems of men, women and children.

"There has been in this conference the dominating thought that the better control of economic forces was in fact simply the better comfort of our country."

Engineers Consider Financing

On Oct. 19 the New York Sections of the A. S. M. E., A. I. E. E., A. S. C. E. and A. I. M. E. met jointly in the Engineering Societies Building. Arthur B. Leach of A. B. Leach & Co., New York, said that it is necessary for us to utilize to their fullest extent the industrial installations that now exist, before we attempt to finance new undertakings. Money for development work goes where it has the best chance of making a profit, but since many of our industries cannot now hope for this, there must necessarily be but small extension of them.

That the engineer is generally a failure as a financial manager was stated by Philip Cabot, of White, Weld & Co., Boston. He said that the engineer is an executor rather than a planner, and ordinarily cannot direct an organization.

Dodd Urges Standardization of Quality and Variety

Part of the tremendous waste in distribution in this country can be eliminated by standardization of the quality, quantity and variety of products, Alvin E. Dodd, manager of the Domestic Distribution Department of the Chamber of Commerce of the United States, told the National Association of Purchasing Agents at the annual meeting just held at Indianapolis.

Scientific Grading

According to Mr. Dodd, the work of the purchasing agents would be simplified if commodities were more scientifically "graded." In unnumbered instances, he said, there is no standard at all to which a purchase may be related.

More and more the purchasing agents have come to rely upon a certain house as the criterion for everything in its line. Its product established the grade of all others of a like kind. It may be belting or rope or chain, or hardware or shirts or awnings. Sometimes the price is a little more, but the purchasing agent knows before the goods are shipped exactly what he is going to get. And it is this confidence on the part of their customers which allows manufacturers to keep their works going when their competitors are shut down tight.

Surprisingly little has been accomplished in the accurate grading of organic products; and indeed surprisingly few attempts have been made toward this very desirable purpose.

A Crying Need

With minerals as with other natural products the case is entirely different. You can buy steel and iron quite definitely, from structural members to watch springs based upon chemical formulas and heat-treatments. Petroleum and its derivatives are thoroughly described by gravity and flash test specifications. The mysteries of lubricants and abrasives are expressed in such simple terms that their purchase involves little if any risk. To extend these facts to other articles of manufacture constitutes a crying need for every one engaged in the purchase of supplies

Business Conditions in England

BY OUR LONDON CORRESPONDENT

One way and another the really serious character of the domestic position of Great Britain is being recognized. Councils and committees are being called and formed with a view to devising remedies for the prevailing unemployment—where some improvement may be visible—the slackening in trade generally and the heavy decline in the public revenue. The last, however, has a way of recovering itself, so that too much need not be made of the deficit shown in the returns for the first half of the current fiscal year. This deficit is more than 41 million pounds, comparing with a surplus exceeding 77 million pounds last year in the same period. In fact, of the total decline of revenue of 200 millions estimated for on the full year ending about the beginning of April next, a drop of 163 millions has already been recorded.

Ways and Means of Taxation

The floating debt has been increased by 45 millions with signs of taking "power to add to the number." The chief failures are apparently from the excess profits duty which has yielded say 27 millions, the corporation profits tax which has so far produced about 6 millions, and the sale of war stores. In the prevailing circumstances it is hardly probable that these items will show real recovery during the next six months. On the other hand the income tax has exceeded the proportionate estimate, showing in fact an increase approaching 14 million pounds as compared with the same period last year. Much depends on the taxing authorities. If they attempt a squeeze they can usually produce more than the estimate; there are always arrears to be recovered. The difficulty of meeting these demands is increased at a time like this, the tax being based on the profits of the previous year when the returns are naturally higher. Customs show a decline, but this is more than balanced by the increase in excise, suggesting that the sums spent on drink are still rising. Thus, while from a taxation point of view income is declining, expenditure is increasing, and a committee has been sitting for the purpose of finding ways and means of reducing the figure considerably, so that, it is hoped, the public expenditure next year will be less than that of the current year by 130 millions.

Prices and Finance

Meanwhile prices continue to show a tendency to decline, and the cost of living figures, at 120 per cent above prewar rates, are only one point beyond the minimum reached two or three months ago. Pressure of public opinion has had its effect on retailers; so too has foreign competition in certain materials and the decline in demand due to the unfortunate decision of the government to scrap the building program. "The ring round the house" has for a year or more been the subject of agitation by one of the London newspapers, but now that there is no assured market the Light Castings Association has had to reduce prices, and still lower prices are quoted by a few firms outside that ring. It has been stated that the profits being made today on some housing materials exceed the pre-war selling price, the selling profits of a merchant in one case being one-and-a-half times this price. After 13 years, the Cast Iron Pipe Association has broken down. Similarly in regard to coal, for various reasons the demand has fallen away, the extraordinary weather—the temperature of days in October has been several degrees higher than for any day in the whole of 1920—continuing to enable the householder to postpone his orders, with the result that, two days after stating it was impossible, London coal merchants—mainly by the threatened break away of one of the members of the ring—actually issued lists of reduced prices, and showed signs of further weaking. Wholesale prices generally are about 80 per cent above pre-war prices, with retail prices increased by 120 per cent.

Burdensome War Debts

Export credit schemes appear, without much effect, in every morning paper. Lectures on public economy are delivered by every chief waster. Much is regularly parroted by every little business man on the stabilization of exchanges; it is one of the favorite remedies for the prevailing depression in overseas trading. Whether the process suggested is practicable is distinctly a moot point. In any case it is an entirely artificial proceeding, and the world is anxious to get back to natural operations. American aid in the rehabilitation of credit is thought very desirable. What is weighing on all countries, and particularly on the countries with any reputation, would seem to be the load of debt incurred during the conduct of the war. If these debts could be removed the possibilities of buying and selling would be enormously enhanced, and people are not wanting in Great Britain who are ready to contend that cancellation or remission all round is the only remedy, that it would be as much to the advantage of the creditor as of the debtor country. As far as can be seen at present the debt can only be paid in goods and the restrictions and handicaps which most countries—Great Britain taking a hand in the game—are placing on imports simply render the situation more difficult. Certainly the load of debt in Great Britain, if only indirectly, is responsible for want of enterprise. It means heavy taxation to provide interest on, to say nothing of redemption of, debt and thus robs industry of much capital that might be risked and even capital needed for mere replacement of plant.

Europe Is Poor

The fact should be recognized that as the result of the war the world, or Europe at least, is very definitely poorer. The food production of the world is apparently somewhere about 20 per cent lower than it was pre-war, and the loss of lives and of material need not be mentioned. Yet it is no unusual thing to meet the assertion that this country or that country, having gained territory, is richer as the result of the war. In detail the statements may appear true, though the inference that the world is better off is mistaken. What is gain to one country is loss to another, and the fact that France or Italy or Great Britain increased their possessions in no sense adds to the sum total of markets available.

Shipbuilding and Repair

Announcement has been made that Harland & Wolff are preparing to build and equip a ship-reparing works near the Royal Albert Docks on the Thames. Shipbuilding is not mentioned and there is consequently nothing in the present announcement to compensate for the loss by London some years ago of this work and of the engineering work which accompanied it. Apart from Yarrows and the closing of the Thames Iron Works, which will be within the memory of most people interested, one need not be very old to recall the names of Penn, Rennie, Maudslay, not to mention Samuda, Miller and Ravenhill, Russell and so on. To return to Harland & Wolff, new slips, workshops, foundry, etc., will be set up and equipped and machine-tool firms have already been endeavoring to get interested. It is understood that the firm will undertake the whole of the repair work called for by the Port of London Authority.

Machine-Tool Industry

The decline continues, where it is possible, in the machine-tool industry, and the government is being severely criticised on account of the further projected series of sales of surplus war stock. The Manchester district still remains most fortunate. Several firms here continue for the present on full time, though firms have shut down, and in one well-known case the only order obtained during the last six months was valued at £900. Motor car repair work is being undertaken. Or again, a firm may have enough work on hand to keep the machine-tool side active till the end of the year, while the small tool shops are almost bare. Similarly there will be no difficulty in finding a machine shop running, if that is the right word, solely on stock. Here again may be noted the fact that it is the maker of special tools rather than the manufacturer in quantities who finds some work to do. For example, whatever may be the case in their other departments, the machine-tool shops of Holroyds at Milnrow are running a full week; but the settled policy of this firm is to undertake nothing except special tools, and it is the textile machinery people mainly who are responsible for the firm's relative good fortune.

Decreased Profits

The report of the Leeds firm of Joshua Buckton & Co., makers of heavier machine tools, testing machinery, etc., confirms the general reading of the situation, for the profits shown are only £13,763, this including an unspecified amount by way of refund of excess profits duty. The dividend

therefore proposed is 2¾ per cent per annum. The balance sheet includes a loan of £48,344 from bankers, secured on debentures, and the outlook as regards orders is frankly described as very unsatisfactory. An amalgamation of interests of some note in the machine-tool world is the union of Fairbairn, Lawson, Combe Barbour, Ltd., of Leeds, Belfast and Lille, with the Scottish firms of Urquhart Lindsay & Co., and Robinson & Orchar, Ltd.

The report of Guest, Keen & Nettlefold is certainly more encouraging than some showings, for the net profit on the year's working of £810,101 is only about £50,000 less than that of last year. The 10 per cent free of tax dividend paid cannot be compared fairly with the usual distribution of 15 per cent. Owing to changes in capitalization, bonus shares to a considerable extent have been distributed out of reserves. Here again the company has been extending its interests by acquiring controls, not only of the Wolverhampton metal firm of Bayliss, Jones & Bayliss, Ltd., but also in coal mining and coal distributing companies. On the other hand, the Steel Company of Scotland shows a net profit for the year of £105,874 against more than £246,000 the previous year, the dividend being 7½ per cent, less tax.

Automotives Fall Flat

Coventry is described as feeling the full effects of the slump but hope springs eternal in the human breast and the motor car industry is now looking forward to the November shows to be held in London. Some firms who had, according to the ballot, arranged to exhibit at the White City, W., find that space is available at Olympia, W., the explanation being that the financial stress has proved too heavy for at least a few organizations. The light car trade has pretty well gone; the home trade has, due to the season, fallen flat, and export shows no improvement. The report of the Rover Co., Coventry, for the year ending with July last must in the circumstances be regarded as satisfactory, for the profits shown on the year's work, namely, £102,320, are not £7,000 less than those of the previous year. The dividend of 10 per cent was this time paid less income tax instead of free of tax, mainly on account of the increase of £350,000 in the ordinary share capital. A bonus distribution in 1919 doubled the shares. The company had a special war contingency fund amounting on the last showing to £50,000. This has been utilized in part to write down stocks and also to provide for cost of converting the Birmingham works for the production of 8-hp. cars.

At the last meeting of the London Iron and Steel Exchange, buyers held off in view of further reduction in prices. A wage reduction of 108 points on the standard of steel workers in the South Wales district has been effected, due to the sliding scale system; wages are based on prices during three months and are now 64½ points above standard. It is further reported that against keen German competition, a Scottish firm secured an order for machinery valued at £70,000 for Rangoon, and further, that numbers of inquiries are being received from South Africa and Australia; here however the long credits called for act somewhat as a handicap.

Business Items

The Black & Decker Manufacturing Co., Baltimore, Md., builders of portable electric tools, has declared a dividend on outstanding preferred stock for the third quarter this year amounting to 2 per cent, or 8 per cent per annum.

The new foundry building of the Gilbert & Barker Manufacturing Co., West Springfield, Mass., which is practically completed, enables the company to add 200 to its working force. The increase will be gradual.

A dinner was given on Oct. 13 at the Engineers Club Boston, to their business associates by William B. McSkimmon and J. Henry Drury. Executives of the Union Twist Drill Co., S. W. Card Manufacturing Co., Butterfield & Co., New England Drawn Steel Co., O. S. Walker Co., Vitrified Wheel Co., Goldmark Knitting Co., and the State Street Trust Co. were present. Mr. McSkimmon was toastmaster and everyone spent a most enjoyable evening.

Fire of unknown origin entirely destroyed the foundry and shops of the Bowie Stove Foundry at Rome, Ga., recently, causing a total loss estimated at about $100,000. The plant had been in operation more than 30 years.

The Lovejoy Tool Co., Inc., manufacturer of metal cutting tools, of Springfield, Vt., has announced a 25 per cent reduction from list price on high-speed steel inserted-cutters for Lovejoy holders. The reduction became effective on Oct. 10.

J. R. McWane, president for some years of the American Cast Iron Pipe Co., of Birmingham, Ala., has resigned his position effective Jan. 1, 1922, to become president of the McWane Pipe Co., another corporation recently formed by Mr. McWane and associates. He will retain his financial interest in the American company and remain a director. The new corporation will manufacture a patent joint for high pressure pipe and also will make 2- and 3-in. pipe to be used with this joint. A plant has been leased in North Birmingham that will be used as shops for the time being.

The United States District Court, sitting at Canandaigua, N. Y., has appointed M. H. Anderson receiver of the Davis Machine Tool Co., of Rochester, N. Y. The assets of the company are placed at $1,130,000 and the liabilities at $283,300. Mr. Anderson is authorized to continue the business or to liquidate it, as he may be directed by the court. The Davis company was organized and incorporated in 1915 with a capital stock of $750,000. John M. Fitzgerald is president.

An order for locomotives has just been placed with the American Locomotive Co. by the Chicago, Rock Island & Pacific for 14 heavy Mikado type engines. The American Locomotive Co. announces it has also recently secured the following orders: Chilian State Railways, 20 broad gage Mikado type engines; Mississippi Central, two Mikado type engines, and La Crosse & Southeastern, one 10-wheeler.

The Hydraulic Steel Co., Cleveland, Ohio, reports for the year ended June 30, 1921, a deficit from operations of $383,901 and a loss from inventory adjustments of $1,500,000, making the total deficit for the year $1,883,901, compared with a net income of $1,020,182 for the previous year. President Foster declares that the business of the company shows improvement and that operations are now being conducted at a profit. In July the volume of business was $247,000, August $440,000 and September $480,000. The October business is expected to reach $550,000.

Directors of the Electric Alloy Steel Co., Youngstown, Ohio, have recommended the authorization of $750,000 convertible cumulative preferred stock, an issue of $500,000 is contemplated and it is understood that the approval of the stockholders is virtually assured. Informal subscriptions for half of the issue have already been made by interests within the company. Proceeds of the new stock are required for working capital. President L. J. Campbell reports that the company's business is improving.

The Chicago Belting Co., of Chicago, Ill., has filed a notice of an increase in capital stock of its Oregon branch from $375,000 to $500,000.

The Lincoln Machine Co., of Pawtucket, R. I., has recently increased its capital stock from $50,000 to $100,000.

A foundry and machine shop is to be established in the near future at La Grange, Ga., by the Duke Boltless Rail Joint Co., a corporation recently formed in that city with $25,000 capital. The incorporators were G. W. Duke, J. T. Thomasson and J. C. Thomas. In addition to manufacturing a boltless rail joint, for which it owns the patents, the company will make other castings and manufacture various steel and iron products.

The Dusenberg Automobile and Motors Co., of Delaware, has applied for incorporation in the State of Indiana. The new organization has a capital stock of $5,000,000, and will manufacture and sell automobiles and parts at Indianapolis.

The Arrow-Light Co., of Springfield, Mass., has been incorporated. Capital stock is $30,000. Officers are Gurdon W. Gordon, president; T. M. Marezul, treasurer.

The Martin Motor Co., of Springfield, Mass., has been organized in that city. Charles J. Glidden is president. The new company will manufacture small automobiles to be built of aluminum and duralumin.

The Modern Die and Tool Co., at Indianapolis, Ind., has been incorporated with a capital stock of $75,000. The company manufactures bearings and tools. Incorporators are W. L. Sandage, Harold W. James and Roger G. Wolcott.

The Indiana Watkins Manufacturing Co. has been organized at Indianapolis with a capital stock of $15,000, for the purpose of manufacturing bearings for automobiles. Organizers are E. A. Watkins, G. H. Oburn and R. W. Schneider.

The Grand Rapids Metal Products Co. has been organized at Grand Rap-

ids, Mich., to manufacture furniture, refrigerator, phonograph and automobile hardware, specialties, etc., as well as to job several kindred lines of well-known manufacturers. The complete plating plant of the Miller Plating Co. has been taken over. John C. Miller for seventeen years with the Wolverine Brass Co., is president; E. R. Freeman is vice-president, and A. W. Honecker is secretary and treasurer.

Immediate errection of a new forge shop 50 x 250 ft., to cost $100,000, and the erection of a large pattern shop, was announced this week by directors of the Alliance Machine Co., Alliance, Ohio. Their own employees will be used in constructing the new buildings. General plant improvements also are contemplated.

The International Westinghouse Electric Co., the Baldwin Locomotive Works, the Pressed Steel Car Co. and the Anaconda Copper Mining Co. have secured a contract to electrify the Chilean State Railroad between Santiago, Los Andes, Valparaiso and Buenos Aires. It is predicted that all the railroads of Chile will be electrified eventually.

The Builder's Steel Co. has been organized at Hartford, Conn., to manufacture iron and steel products. Incorporators are Samuel Rome, Abram Ozia and Harry Ogens.

The plant of the Precision Engineering Co., at Jamestown, N. Y., was totally destroyed by fire on Oct. 4. A quantity of machinery, tools and equipment was rendered useless.

The Frank Miller Co. has been incorporated at Trenton, N. J., to deal in steel, iron and metals. Capital stock is given as $250,000. Directors are S. Lewis, Jacob Vine and R. Miller.

The Arctic Pump Manufacturing Co. has been organized at Spokane, Wash., to make and sell an engine cooling device for Ford cars. Capital stock is $100,000. Directors are G. B. Kemp, R. S. McClintock and H. L. Kemp.

The Bush Manufacturing Co., Hartford, Conn., manufacturer of automobile, truck and airplane radiators, has purchased the plant of the Ellison Construction Co., in Hartford. Due to the expansion of business, more room was required for working facilities.

Personals

GEORGE L. SAWYER, formerly sales manager of material handling machinery for the Barber-Greene Company, Aurora, Ill., has been appointed to represent the Universal Crane Co., of Elyria, Ohio, in the New York field. His offices are at the Allied Machinery Center, 141 Center St., New York City.

JOHN J. EAGAN, of Atlanta, has been chosen to succeed J. R. McWane as president of the American Cast Iron Pipe Co., Birmingham, Ala. Mr. Eagan is also chairman of the board of directors.

MAYOR JAMES E. HIGGINS, of Chicopee, Mass., has recently sold out his interests in the Higgins & Company, brass foundry, Holyoke, Mass. to his partner Frank Williams. Mr. Higgins has been identified with the business for the past 35 years.

J. M. LLOYD has resigned as superintendent of Lowellville, Ohio, plant of the Sharon Steel Hoop Co. at Sharon, Pa.

E. H. WARNER, well-known in the machinery world through his long connection with the Cowdrey, Fitchburg Machine, Fairbanks and other machinery building concerns, has established himself as a direct factory representative for several manufacturers. He is now located at 76 West Alvord St., Springfield, Mass..

H. W. HEINRICH, manager of the Latin-American department of the export department of the Yale & Towne Manufacturing Co., of Stamford, Conn., has recently returned from a three months' business trip to Cuba, Santo Domingo and Porto Rico.

G. M. GRAHAM on Nov. 1 will become a vice-president of the Chandler Motor Car Company, in charge of sales, service and advertising. Mr. Graham was formerly a vice-president of the Pierce-Arrow Motor Car Co.

WILLIAM M. CHAMBERLIN has been appointed as assistant to the vice-president, in charge of sales, of the Maxwell and the Chalmers Motor Sales companies. He will devote his time to developing better merchandising methods.

LYLE W. ORR, general manager of the Modern Tool Co., Erie, Pa., has resigned his position but will retain his interest in the company.

FRANK TRABOLD has resigned as vice-president of J. H. Williams & Co., of Brooklyn, N. Y., which company he has served for twenty years. Mr. Trabold has opened offices at 30 Church St. ,but has not as yet completed his plans for the future.

M. A. GREEN, for ten years superintendent of branches and agencies of the Crucible Steel Co., of America, has been appointed manager of the tool steel department of John Henry Andrews & Co., Ltd., of Sheffield, England.

Obituary

ROBERT LAWRENCE AHLES, forty-three years old, died at Westbury, L. I., on Oct. 17. Mr. Ahles for many years was prominent in the steel industry. He was at the time of his death, president of the Sweet's Steel Co. of Williamsport, Pa., where he resided. He was formerly identified with the Hewitt interests in northern New Jersey, where he operated blast furnaces.

JULIUS J. D. MCNAMARA, 65 years old, manufacturer of engines, died unexpectedly on Oct. 9 at his residence in Newark, Ohio.

LORENZO DOW HAWKINS, of Stoneham, Mass., died on Oct. 12 in his ninetieth year, as the result of a recent fall. Mr. Hawkins was for many years a manufacturer of elevators and of shoe machinery, as head of the old-time Boston firm of L. D. Hawkins & Co.

JOSIAH GIBSON, treasurer of the Marsh Motor Car Co., Cleveland, Ohio, died on Sept. 28.

Export Opportunities

The Bureau of Foreign and Domestic Commerce, Department of Commerce, Washington, D. C., has inquiries for the agencies of machinery and machine tools. Any information desired regarding these opportunities can be secured from the above address by referring to the number following each item.

A merchant in Italy desires to purchase or secure an agency for the sale of iron and steel, scrap iron and steel. Quotations should be given c.i.f. Genoa or Naples. Reference No. 137.

A firm in Victoria, Australia, which has taken up the manufacture of light tractors and motor trucks, wishes to be placed in communication with firms for the purchase of suitable engines and transmissions. Prices and full particulars are requested. Reference No. 122.

A business man in Spain desires to get into touch with manufacturers and exporters of aëroplanes and motor boats. Catalogs and price lists should be forwarded as soon as possible. Reference No. 128.

A merchant in Norway desires to purchase and secure an agency for the sale of metals and iron and steel. Quotations should be given f. o. b. New York. Reference No. 149.

Local manufacturers of chocolates in a city of Ecuador are planning to extend and improve their factories, and desire to receive catalogs of machinery and apparatus. None of the manufacturers have produced heretofore more than 1,500 pounds daily. Reference No. 161.

The owners of a coal mine in Colombia desire to be placed in touch with American firms for securing an aerial cable for transporting coal, and machinery appropriate for use in briquetting coal in the form used for export purposes. Reference No. 162.

The Commonwealth engineers in South Australia desire to purchase and secure an agency for the sale of stationary engines and irrigation machinery, suitable for agriculture. Quotations should be given f. o. b. New York. Payment, cash against documents. Reference No. 169.

An importer in India desires to purchase large consignments of structural steel, beams, girders, rails, bolts, and nuts. Quotations should be given c. i. f. Indian port. Reference No. 171.

Trade Catalogs

Vertical Shapers. Pratt & Whitney Co., Hartford, Conn. Circular No. 269 illustrating and describing the 6 and 8-in. vertical shapers of this company.

Seybold Automatic Cutter. E. P. Lamson Co., Inc., New York, N. Y. An eight-page catalog devoted to a description of the improved Seybold machine for cutting paper and like materials.

Concrete Bins and Pits for Coal Storage. Portland Cement Association. Pamphlet showing increased use of concrete in building storage bins for coal.

Autovent Fans. Autovent Fan and Blower Co., Chicago, Ill. Eighth edition catalogs, describing the latest types of autovent fans, Uni-blade blowers and exhausters.

Forthcoming Meetings

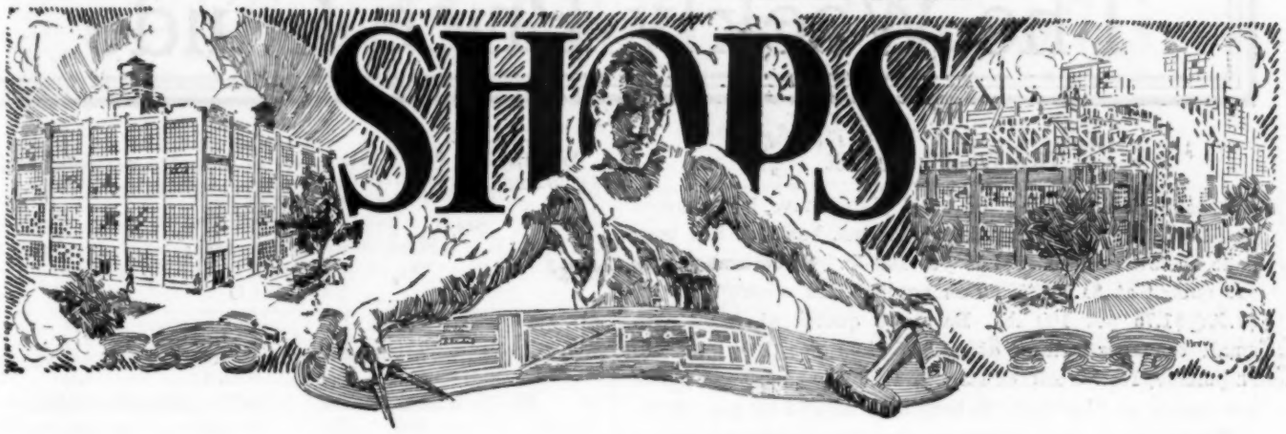
The annual convention of the Industrial Relations Association, of America, will be held in the Waldorf-Astoria Hotel, New York City, on Nov. 1, 2, 3 and 4.

The National Conference of the Industrial Cost Association will be held at Pittsburgh, Pa., on Nov. 2, 3 and 4.

The third annual convention and exhibition of the American Gas Association will be held in the Congress and Auditorium Hotels, Chicago, Ill., on Nov. 7 to 12.

The twenty-fifth annual convention of the National Founders' Association will be held in the Hotel Astor, New York City, on Nov. 16 and 17.

NEW *and* ENLARGED



Machine Tools and Machinery Wanted

Machine-tool wants published without charge

N. Y., Buffalo—J. Wagner, 192 Villa Ave. —11 or 12 in. machine lathe.

N. Y., New York—Bd. Educ., P. Jones, Supt. of School Supplies, Park Ave. and 59th St., receives bids until Oct. 31 for machine tools, machinery, miscellaneous hand tools and materials, principal items as follows:

One 13 in. swing by 5 ft. bed, loose change gear, Star engine lathe.
One Reed Prentice, 14 in. x 6 ft. engine lathe.
One Hendey, cone type screw cutting engine lathe with equipment.
Four speed lathes, 1 in. x 4 ft.
Forty-eight bench lathes, 32 to 38 in. length, 7 to 9 in swing.
Forty-one engine lathes, 11 in. x 4 ft.
Thirty-six No. 211 lathes with 12 in. swing, 4 ft. bed and 12 with 12 in. swing, 5 ft. bed.
One Washburn, 14 in. sensitive drill.
One Hisey electric drill, 2 speed, Model K. A.
One Barnes, 20 in. upright drill.
One Yankee, 2 speed breast drill
One U. S. sensitive, 14 in. floor drill.
Two Willey electric driven portable drills.
One 14 in. U. S. sensitive drill press.
One 20 in. drill press.
One 24 in. sliding head, drill press.
Five Greenerd arbor presses, No. 2 and one No. 3.
One "Perfection" combination arbor press, 30 tons capacity.
One Fairbanks, 20 in. back geared drill press.
Ten 14 in. sensitive drill presses.
Four 20 in. fixed-head drill presses.
One No. 25 plain milling machine, Bilton or Becker.
One No. 1 Kempsmith universal milling machine.
One Marvel cylinder reboring machine, 2½ in. to 8 in. capacity with equipment.
One back geared 16 in. Hendey shaper.
One 17 in. x 20 in. x 9 ft. planer.
One No. 3 Robertson, 6 in. x 6 in. high speed, power driven hack saw.
One B. & S. No. 1 Universal grinder.
One twist drill grinder (Wilmarth or Norman).
One U. S. ball-bearing bench grinder.
One Hisey grinder.
One 14 in. wet tool grinder.
One 10 in. dry grinder.
One 12 in. speed lathe, 72 in. bed.
One Vertical hollow chisel mortiser, with compound table.
Forty-eight Wells manual training lathes.
One single surface planer.
One 3 roller cylinder press, 28 x 41 in. bed with equipment (Babcock-Optimus).

Specifications may be obtained by writing the Bd. Educ.

Pa., Phila.—F. Pettit, 809 Master St.—several machines for ornamental iron works.

Pa., Phila.—W. H. Robinson, 1823 Ludlow St.—metal stamping and electro plating machinery.

Pa., Phila.—School Dist., 19 and Chestnut Sts., W. Dick, Supt. of Supplies—bids will be received until Nov. 3, for lathes, drills, etc.

Ga., Columbus—T. Houston Mfg. Co., 30th St., manufacturers of Machinery—Key-seating machine for outside work with shafts for keys up to ¾ in.

Baker machine or equivalent for inside key seating up to ¾ in.

One 36 in. lathe, about 10 ft. bed, large face plate, extra compound rest, 4 jaw chuck, prefer brass bearing in head stock (used).

Ill., Chicago—Accessories Mfg. Co., 2311 North Crawford Ave.—one 20 ton screw press.

Ind., East Chicago—The Union Iron Products Co., 148th St., manufacturer of metal culverts—rotary ring and circular shear, 14 gage capacity.

Mich., Detroit — Zang-Marvin Co., 130 Cadillac Sq.—one No. 7 Burke miller, No. 3 Barber Coleman gear hobber, and one 8 in. chain pull, counter shafts.

O., Columbus—The Capitol Motor Car Co., 32 South 4th St., C. D. Beck, Service Mgr. —2 or 3 air compressors and drills, 1 lathe and other equipment.

Wis., Columbus—The Columbia Auto Repair & Paint Co., F. Menke, Purch. Agt.—repair machinery and automatic paint applying brushes.

Wis., Madison—The Purcell Wischau Co., 219 East Washington Ave.—lathes, presses (1 and 2 ton), etc.

Wis., Milwaukee—F. J. Hanson, 463 Lenox St.—one lathe for auto repair shop.

Wis., Milwaukee—E. C. Kahn, 4129 Highland Blvd., (machinist)—drill presses.

Que., Montreal — J. Buckley Co., St. Nicholas Bldg., St. Nicholas Ave.—one 48 in. roll turning lathe.

N. Y., Lewiston — The Riverview Upholstering Co.—feather renovating machine.

Pa., Phila.—Co.-Ed Knitting Mills, 1542 Frankford Ave., B. M. Cohn, Pres.-general machinery for the manufacture of neckwear, scarfs and novelties.

Ala., Anniston—The Union Fdry. Co.—jointer, belt driven, 12 to 20 in. blade (good condition).

Fla., St. Petersburg—The Marine Ways Mch. Co., Inc., K. Grable—automatic machine for making pipe nipples from ¼ in. to 1¼ in.

S. C., Columbia—The Halo Co., E. M. Lowman, Secy.—small temporary outfit for manufacture of syrup.

Va., Roanoke — The Harris Hardwood Co., Inc., manufacturers of hardwood flooring, etc., G. L. Wade, Mgr.—planing mill machinery hardwood floorer, gang rip circular resaw, swing cut-off, file room equipment, etc.

Ill., Chicago—W. S. Mole, 2821 Prairie Ave.—complete line of machinery for the manufacture of gas mantels.

Ill., Marengo—The Bd. Educ.—manual training equipment for proposed high school.

Ill., McHenry—The Bd. Educ., c/o O. G. Treadway, Supt. — manual training equipment for proposed high school.

Mich., Roseville — The White Eagle Furniture Co., Fraser and Michigan Aves. —belt sander, swing saw, all steel veneer press (used).

O., Cincinnati — The Greaves Machine Tool Co., 2420 Spring Grove Ave., W. Greaves, Secy. and Treas.—one gear tooth rounding machine.

Wis., Beaver Dam—Ruland & Price—refrigerating and butter-making machinery.

Wis., Cumberland—Cumberland Creamery Assn.—refrigerating machinery and belt driven butter-making machinery, including separators and churns.

Wis., Kaukauna—The Valley Pulp Co.—beaters, etc. for proposed mill.

Wis., Milwaukee—N. Leonard, 801 24th Ave.—one woodworking lathe with motor.

Wis., Milwaukee—Luick Ice Cream Co., Ogden Ave. and Jackson St.—special ice cream making machinery.

Wis., Owen—W. F. Weaver, (millworker) —rip saws.

Wis., Racine—Hansen & Nielser, 1622 Grange Ave., R. C. Hansen, Purch. Agt.—wood working machinery.

Ark., Texarkana—Williams Mchy. Co., P. O. Box 356.—saw mill equipment, grist mills, farm machinery, gasoline engines, etc.

Mo., Independence—Good Mom Products Co., C. A. Birdsall, Pres.—paper package machinery.

Mo., Kansas City — The Western Rock Salt Co., 514 New York Life Bldg.—hydraulic jack, 40 ton capacity.

Tex., Weslaco—A. K. Mattingly, P. O. Box 96—machinery for canning plant.

Ont., Dresden—Lawrence & Wakefield—flour mill machinery and equipment.

Ont., Preston—E. B. Salyerds—machinery for making hockey sticks and wood specialties.

Metal Working Shops

NEW ENGLAND STATES

Conn., South Norwalk — The Norwalk Lock Co., Marshall St., has awarded the contract for the construction of a 1 story, 50 x 100 ft. factory. Estimated cost, $30,000.

Conn., Waterbury—G. W. Russell is having plans prepared for the construction of a 1 story, 60 x 135 ft. garage on Cottage Pl. J. S. LaDow, 51 Leavenworth St., Archt.

Conn., Waterbury—H. Weyand Co., 16 Jefferson St., has awarded the contract for the construction of a 3 story, 82 x 110 ft. plant on Judd St., for the manufacture of sheet metal skylights.

Mass., Boston—Meisel Press Mfg. Co., 944 Dorchester Ave., will soon award the contract for the construction of a 1 story, 300 x 400 ft. machine shop near Locust St. Estimated cost, $300,000. McNaughton & Cleverdon, 19 Congress St., Archts. Noted May 26.

The Weekly Price Guide

This Week's Market

Pittsburgh mill prices on steel plates have been quoted at $1.60@$1.65 for small tonnages; but business has been done as low as $1.50@$1.55 per 100 lb. Structural shapes are quoted at $1.50@$1.65 as against last week's price of $1.60@$1.75 per 100 lb. Bars are quoted at $1.50 with small tonnages selling at $1.60@$1.65 per 100 lb. Mill shipments, New York, of structural steel shapes and plates are quoted at $1.98@$2.13; bars at $1.88@$2.03 per 100 lb.

Wrought-iron pipe discounts, since the Pittsburgh basing card of Sept. 16, have increased an even 5 per cent on all sizes from ⅜ to 12 in., both black and galvanized.

Electrolytic copper is quoted, to the consumer in New York warehouses, at 13¾c., as against 13⅝c. and tin at 28¾c. as compared with 27½c. per lb. previously.

IRON AND STEEL

PIG IRON — Per gross ton — Quotations compiled by The Matthew Addy Co.:

CINCINNATI	
No. 2 Southern	$24.50
Northern Basic	22.52
Southern Ohio No. 2	23.52
NEW YORK—Tidewater Delivery	
Southern No. 2 (Silicon 2.25 to 2.75)	30.26
BIRMINGHAM	
No. 2 Foundry	20.00
PHILADELPHIA	
Eastern Pa., No. 2x, 2.25-2.75 sil	22.75
Virginia No. 2	28.74
Basic	20.75
Grey Forge	21.75
CHICAGO	
No. 2 Foundry local	22.70
No. 2 Foundry, Southern, sil 2.25@2.75	26.66
PITTSBURGH, including freight charge from Valley	
No. 2 Foundry	22.96
Basic	21.96
Bessemer	21.96

SHEETS—Quotations are in cents per pound in various cities from warehouse; also the base quotations from mill:

Blue Annealed	Pittsburgh, Large Mill Lots	New York	Cleveland	Chicago
No. 10	2.50	3.28	3.10	3.38
No. 12	2.60	3.33	3.15	3.43
No. 14	2.70	3.38	3.20	3.48
No. 16	2.80	3.48	3.30	3.58
Black				
Nos. 17 and 21	2.85	4.05	3.55	3.95
Nos. 22 and 24	2.90	4.10	3.60	4.00
Nos. 25 and 26	2.95	4.15	3.65	4.05
No. 28	3.00	4.25	3.75	4.15
Galvanized				
Nos. 10 and 11	3.00	4.25	3.75	4.15
Nos. 12 and 14	3.10	4.35	3.85	4.25
Nos. 17 and 21	3.40	4.65	4.15	4.55
Nos. 22 and 24	3.55	4.80	4.30	4.70
No. 26	3.70	4.95	4.55	4.85
No. 28	4.00	5.25	4.75	5.15

WROUGHT PIPE—The following discounts are to jobbers for carload lots on the Pittsburgh basing card of Sept. 16, 1921:

BUTT WELD

Steel Inches	Black	Galv.	Iron Inches	Black	Galv.
1 to 3	68½	56	¾ to 1½	44½	29½
LAP WELD					
2	61½	49	2	39½	25½
2½ to 6	65½	53	2½ to 4	42½	29½
7 to 8	62½	49	4½ to 6	42½	29½
9 to 12	62½	49	7 to 12	40½	27½
BUTT WELD, EXTRA STRONG, PLAIN ENDS					
1 to 1½	66½	55	1 to 1½	44½	30½
2 to 3	68½	56			
LAP WELD, EXTRA STRONG, PLAIN ENDS					
2	59½	48	2	40½	27½
2½ to 4	63½	52	2½ to 4	43½	31½
4½ to 6	62½	51	4½ to 6	42½	30½
7 to 8	58½	45	7 to 8	35½	23½
9 to 12	52½	39	9 to 12	30½	18½

Malleable fittings. Classes B and C, Banded, from New York stock sell at net list. Cast iron, standard sizes, 20–5% off.

WROUGHT PIPE—Warehouse discounts as follows:

	New York Black	New York Galv.	Cleveland Black	Cleveland Galv.	Chicago Black	Chicago Galv.
1 to 3 in. steel butt welded	60%	46%	60½%	47½%	68½%	56%
3½ to 6 in. steel lap welded	51%	37%	58½%	44½%	65½%	53%

Malleable fittings. Classes B and C, Banded, from New York stock sell at list less 5%. Cast iron, standard sizes, 32% off.

MISCELLANEOUS—Warehouse prices in cents per pound in 100-lb. lots:

	New York	Cleveland	Chicago
Open hearth spring steel (heavy)	5.00	6.00	*3.78
Spring steel (light)	6.00	6.00	†8.50
Coppered Bessemer rods (base)	8.00	8.00	*6.03
Hoop steel	3.88	3.29	3.48
Cold rolled strip steel	7.50	8.25	6.75
Floor plates	4.85	....	5.23
Cold finished shafting or screw	3.88	3.50	4.00
Cold finished flats, squares	4.38	4.00	4.50
Structural shapes (base)	2.88	2.74	2.88
Soft steel bars (base)	2.78	2.64	2.78
Soft steel bar shapes (base)	2.78	2.64	2.78
Soft steel bands (base)	3.43	....	....
Tank plates (base)	2.88	2.92½	2.88
Bar iron (2.15@2.25)	2.78	3.52	2.78
Drill rod (from list)	55@60%	55%	50%

Electric welding wire..... New York ⅜, 8½c. per lb.; ½, 7.15c.; ⅝ to ¼, 6.75c. Swedish iron sells at 9c. per lb. in Chicago. *Price to dealers. †Carriage spring steel.

METALS

Current Prices in Cents Per Pound

Copper, electrolytic (up to carlots), New York	13.75
Tin, 5-ton lots, New York	28.75
Lead (up to carlots), St. Louis, 4.60; New York	5.00
Zinc (up to carlots), St. Louis, 4.97½; New York	5.37½

	New York	Cleveland	Chicago
Aluminum, 98 to 99% ingots, 1-15 ton lots	25.00	25.00	20.00
Antimony (Chinese), ton spot	5.50	6.00	6.50
Copper sheets, base	20.75	21.50	20.50
Copper wire (carlots)	16.50	16.50	15.50
Copper bars (ton lots)	19.00	23.00	18.00
Copper tubing (100-lb. lots)	20.50	23.00	20.50
Brass sheets (100-lb. lots)	16.25	16.00	16.25
Brass tubing (100-lb. lots)	18.00	18.00	18.00
Brass rods (1,000-lb. lots)	14.25	16.00	14.25
Zinc sheets (casks), (8% dis. carlots)	11.00	11.15	15.75
Nickel (ingot and shot), Bayonne, N. J.	41.00	....	....
Nickel (electrolytic), Bayonne, N. J.	44.00	....	....
Solder (½ and ½), (case lots)	19.50	23.50	17.50
Babbitt metal (best grade)	70.00	39.00	32.00
Babbitt metal (commercial)	30.00	13.50	8.00

—Shop Materials and Supplies

MONEL METAL—Base price in cents per lb., f.o.b. Bayonne, N.J.:

Shot	35.00	Hot rolled machined rods (base)	53.00
Blocks	35.00	Hot rolled rods (base)	42.00
Ingots	38.00	Cold drawn rods (base)	56.00
Sheet bars	40.00	Hot rolled sheets (base)	55.00

SPECIAL NICKEL AND ALLOYS—Price in cents per lb.

Malleable nickel ingots	45
Malleable nickel sheet bars	47
Hot rolled rods, Grades "A" and "C" (base)	60
Cold drawn rods, Grade "A" and "C" (base)	72
Copper nickel ingots	37
Hot rolled copper nickel rods (base)	45
Manganese nickel hot rolled (base) rods, "D"—low manganese	64
Manganese nickel hot rolled (base) rods "D"—high manganese	67

OLD METALS—Dealers' purchasing prices in cents per pound:

	New York	Cleveland	Chicago
Copper, heavy, and crucible	10.00	10.50	10.25
Copper, heavy, and wire	9.50	10.50	9.50
Copper, light, and bottoms	8.00	8.00	8.25
Lead, heavy	4.00	3.75	3.75
Lead, tea	3.00	2.75	3.00
Brass, heavy	6.50	6.00	8.00
Brass, light	5.00	4.00	4.75
No. 1 yellow brass turnings	5.25	4.50	5.25
Zinc	3.00	2.00	2.75

TIN PLATES—American Charcoal Plates—Bright—Cents per lb.

			New York	Cleveland	Chicago
"AAA" Charcoal Melyn Grade:					
IC,	20x28,	112 sheets	21.50	.....	.....
IX,	20x28,	112 sheets	24.00	.....	.....
IXX,	20x28,	56 sheets	13.75	.....	.....
IXXX,	20x28,	56 sheets	15.50	.....	.....
IXXXX,	20x28,	56 sheets	17.00	.....	.....
"A" Charcoal Allaways Grade:					
IC,	20x28,	112 sheets	18.50	.....	.....
IX,	20x28,	112 sheets	21.50	.....	.....
IXX,	20x28,	56 sheets	12.25	.....	.....
IXXX,	20x28,	56 sheets	14.00	.....	.....
IXXXX,	20x28,	56 sheets	15.75	.....	.....

Coke Plates, Bright

Prime, 20x28 in.:				(56 sheets)
80-lb,	112 sheets	13.60	.....	.....
90-lb.,	112 sheets	13.80	.....	.....
100-lb.,	112 sheets	14.00	6.50	.....
IC,	112 sheets	14.30	6.65	.....
IX,	112 sheets	16.30	.....	.....
IXX,	56 sheets	9.15	.....	.....
IXXX,	56 sheets	10.15	.....	.....
IXXXX,	56 sheets	11.15	.....	.....

Terne Plate

Small lots, 8-lb. Coating:				
100-lb.,	14x20	7.50	6.25	6.25
IC,	14x20	7.75	6.50	6.50

SHOP SUPPLIES

	New York	Cleveland	Chicago
Machine Bolts:			
All sizes up to 1x30 in.	—50%	—60%	—60-5%
1⅛ and 1¼x3 in. up to 12 in.	—40%	60-10-10%	—55%
With cold punched sq. nuts	—30%	.....	....
With hot pressed hex. nuts up to 1x30 in. (plus std. extra of 10%)	—40%	.....	.....
Up to 1-in. diameter, with cold punched hex. nuts (plus std. extra of 10%)	—30%	.....	.....
Button head bolts, with hex. nuts	—20%	$3.90 base	.....
Hex. head and hex. nut bolts	—20%	.....	.....
Lag screws, coach screws	—50-10%	.....	.....
Carriage bolts, all sizes up to 1 in. x 30 in.	—45%	50-10-10%	50-5%
Bolt ends, with hot pressed nuts	—50%	.....	.....
Tap bolts, hex. heads	—20%	.....	.....
Semi-finished nuts, all sizes	—70%	75%	75%
Case-hardened nuts	—60%	.....	.....
Washers, cast iron, ½ in., per 100 lb.	$5.00	$5.50 off	$4.50
Washers, cast iron, ⅝ in. and larger, per 100 lb	4.25	3.75 off	4.50
Washers, round plate, off list per 100 lb.	3.00	.....	.....
Nuts, hot pressed, sq.	Off list	2.00	3.00	3.00
Nuts, hot pressed, hex.	Off list	2.00	3.00	3.00
Nuts, cold punched, sq.	Off list	1.50	3.00	3.00
Nuts, cold punched, hex.	Off list	1.50	3.00	3.00
Rivets:				
Rivets, $\frac{7}{16}$ in. dia. and smaller		50-10%	60-10-10%	-60-10%
Rivets, tinned		-50-10%	60-10-10%	4½c. per lb. net
Button heads ¾-in., ⅞-in., 1x2 in. to 5 in., per 100 lb		$3.70	3.50	3.68
Cone heads, ditto		3.80	3.60	3.78
1⅛ to 1¾-in. long, all diameters, *EXTRA* per 100 lb		0.25	.....	....
⅞ in. diameter	*EXTRA*	0.15	.....	....
½ in. diameter	*EXTRA*	0.50	.....	....
1 in. long, and shorter	*EXTRA*	0.50	.....	....
Longer than 5 in.	*EXTRA*	0.25	.....	....
Less than 200 lb.	*EXTRA*	0.50	.....	....
Countersunk heads	*EXTRA*	0.35	.....	....
Copper rivets		50-10%	40-10%	40%
Copper burs		25-10%	15%	20%

MISCELLANEOUS

	New York	Cleveland	Chicago
Cotton waste, white, per lb.	$0.07½@$0.10	$0.12	$0.12
Cotton waste, mixed, per lb.	.055@.09	.09	.10
Wiping cloths per M., 13¼x13¼	.....	55.00	55.00
Wiping cloths per M., 13¼x20½	.....	65.00	65.00
Sal soda, 100 lbs	2.10	3.00	2.65
Roll sulphur, 2-bbl. lots per 100 lb	2.55	3.25	2.75
Linseed oil, per gal., 5 bbl. lots	.73	.80	.81
White lead, dry or in oil	100 lb. kegs.	New York, 12.25	
Red lead, dry	100 lb. kegs.	New York, 12.25	
Red lead, in oil	100 lb. kegs.	New York, 13.75	
Fire clay, per 75 lb. bag		.80	.80
Coke, prompt furnace, Connellsville	per ton	$3.35@3.50	
Coke, prompt foundry, Connellsville	per ton	4.25@4.75	

R. I., Woonsocket — The Regina Auto Sales Co., Front St., has awarded the contract for the construction of a 2 story, 60 x 80 ft. garage, etc., on Front. Estimated cost, $40,000.

MIDDLE ATLANTIC STATES

Pa., Philadelphia—T. Clark, 2728 North 2d St., has awarded the contract for the construction of a 1 story, 30 x 60 ft. addition to his machine shop at 2732 North 2d St. Estimated cost, $5,000.

Pa., Philadelphia — J. E. Fieldstein, Archt., 901 Walnut St., will receive bids until Nov. 1 for the construction of a 3 story, 89 x 100 ft. garage and service station on Broad St. and Bainbridge Ave., for the Walton Auto Supplies, Inc. D. Perry, Treas. and Mgr.

Pa., Philadelphia—C. K. Guerard, 6422 Oak Ave., has awarded the contract for the construction of a 1 story addition to his machine shop at 1510 Vine St. Estimated cost, $5,000.

Pa., Philadelphia—Ivins Tube Wks. is building a 1 story, rolling mill on Oak Lane, Coventry and Chestnut Sts., for the manufacture of steel tubes. Estimated cost $250,000.

Pa., Philadelphia—F. Pettit, 809 Master St., has awarded the contract for the construction of a 2 story, 99 x 108 ft. manufacturing plant for the manufacture of ornamental iron works, at 809 Master St. Estimated cost, $15,000.

Pa., Pittsburgh—The Cunningham Sales Co., 510 Liberty St., has awarded the contract for the construction of a 2 story, 85 x 100 ft. garage and sales building. Estimated cost, $100,000. Noted Sept. 8.

Pa., Pittsburgh—The Standard Underground Cable Co., Westinghouse Bldg., has awarded the contract for the construction of an addition to its plant between 16th and 17th Sts. Estimated cost, $500,000.

SOUTHERN STATES

W. Va., Point Pleasant—The Auto-Motor Corp., Charleston, W. Va., will open bids about Nov. 15 for the construction of a 4 story factory, consisting of 3 units, here. Estimated cost, $250,000. L. C. Pritchard, Genl. Mgr.

MIDDLE WEST STATES

Ill., Aurora—F. J. Fidler, 16 North La Salle St., plans to construct a 1 story garage. Estimated cost, $40,000. Architect not selected.

Ill., Centralia—J. Longenfeld is having plans prepared for the construction of a 2 story, 80 x 106 ft. garage. Estimated cost, $40,000. Architect's name withheld.

Ill., Chicago — S. Porcaro, 2544 West Superior St., has awarded the contract for the construction of a 2 story, 72 x 120 ft. addition to his garage at 2435 Division St. Estimated cost, $40,000.

Ill., East St. Louis—C. O. McCaskand, 810 Chestnut St., St. Louis, Mo., is having plans prepared for the construction of a 1 story, 70 x 120 ft. garage on 10th and Illinois Aves., here. Estimated cost, $55,000. Architect's name withheld.

Ill., Harvard — Cowen & Obert, Crystal Lake, are having plans prepared for the construction of a 1 story, 82 x 90 ft. garage, here. Estimated cost, $40,000. M. A. Stafford, Harvard, Archt.

Ill., Harvard — The Manley Motor Co., c/o B. Manley, is having plans prepared for the construction of a 1 story, 68 x 113 ft. garage. Estimated cost, $40,000. M. A. Stafford, Harvard, Archt.

Ill., Joliet—The Pub. Service Co. is having plans prepared for the construction of a 1 story, 60 x 100 ft. garage. Estimated cost, $40,000. H. Von Holst, 72 West Adams St., Chicago, Archt.

Ill., Pekin—The Conaghan Motor Co., is having plans prepared for the construction of a 1 story garage. Estimated cost, $200,000. J. Zimmer, 217 Court St., Archt.

Ill., Woodstock—The Cross Mfg. Co., c/o E. Wittenburg, Amer. Natl. Bank, plans to construct a 2 story factory for the manufacture of auto shock absorbers. Estimated cost, $35,000. Architect not selected.

O., Cleveland—W. N. Goodman, 1327 East Blvd., has awarded the contract for the construction of a 1 story, 47 x 97 ft. garage and repair shop on East 14th St. and Webster Ave. Estimated cost, $40,000.

O., Cleveland—P. R. Morren Fdry., 4260 East 98th St., has had plans prepared for the construction of a 1 story, 40 x 102 ft. and 16 x 70 ft. foundry and pattern shop at 10010 Dunlap Ave. Estimated cost, $40,000. Private plans.

O., Cleveland—Richmond Bros., 1600 East 55th St., have had plans prepared for the construction of a 1 story 66 x 90 ft. garage at 1600 East 55th St. Estimated cost, $40,000. Christian, Schwartzenberg, & Gaeda, 1900 Euclid Ave., Archts.

O., Cleveland—The Simon Sign Co., 1729 East 12th St., has awarded the contract for the construction of a 2 story, 43 x 120 ft. factory on East 19th St. and Caton Court. Estimated cost, $40,000.

Wis., Madison—The Purcell Wischau Co., 219 East Washington Ave., is receiving bids for the construction of a 2 story, 117 x 132 ft. garage on West Gilman St. Estimated cost, $125,000. Private plans.

Wis., Milwaukee—The West Side Garage, 2310 Lisbon Ave., will receive bids until Oct. 30 for the construction of a 2 story, 96 x 120 ft. garage and storage plant on Lisbon Ave. Estimated cost between $50,000 and $60,000. Private plans.

WEST OF THE MISSISSIPPI

Mo., Carthage — The Carthage Superior Spring Bed Mfg. Co. plans to construct a 2 story factory. Estimated cost, $40,000. Architect not selected.

Mo., Leeds—The Kansas City Spiral Pipe Co., c/o E. J. Gordan, Secy., Dwight Bldg., Kansas City, is having plans prepared for the construction of a 1 story, 60 x 300 ft. factory. Estimated cost, $50,000. Architect's name withheld.

Mo., St. Louis—The Chester Iron & Fdry. Co., c/o A. J. Schaelieh, Pres., 7800 Vulcan St., is having plans prepared for the construction of a 1 story, 45 x 117 ft. cast iron foundry. Estimated cost, $40,000. L. Haeger, 3844 Utah St., Archt.

Mo., St. Joseph—The Grant Motor Co., 9th and Felix Sts., is having plans prepared for the construction of a 1 story, 120 x 140 ft. garage on 10th and Francis Sts. Estimated cost, $55,000. Architect's name withheld.

Mo., St. Louis—B. Gustavson, 1538 Tower Grove, is having plans prepared for the construction of a 1 story, 41 x 175 ft. garage. Estimated cost, $45,000. Wedmeyer & Nelson, Wainwright Bldg., Archts.

Mo., St. Louis—The St. Louis & San Francisco Ry., Frisco Bldg., has awarded the contract for the construction of a 1 story, 40 x 130 ft. machine shop at 3865 Cheateau St. Estimated cost, $55,000. Noted Oct. 6.

Mont., Bozeman—The Bd of Trustees University of Montana, State Capitol, Helena, will receive bids until Dec. 20 for the construction of an engineering building and shops, at the College of Agriculture and Mechanic Arts, here. Estimated cost, $350,000. F. Wilson, Bozeman, Archt.

WESTERN STATES

Cal., Sacramento—The State Hy. Comn., will soon award the contract for the construction of a maintenance shop on 34th and R Sts. Estimated cost, $76,900.

CANADA

Que., Montreal—The Kennedy Taxi Co., Cathcart St., has awarded the contract for the construction of a 2 story, 56 x 110 ft. garage. Estimated cost, $40,000.

General Manufacturing

MIDDLE ATLANTIC STATES

D. C., Washington—The Knickerbocker Ice Co., 1480 Bway., will soon award the contract for the construction of an ice plant. Estimated cost, $250,000. Private plans.

N. Y., Buffalo—The Amer. Grain & Feed Corp., 303 Chamber of Commerce, is having plans prepared for the construction of a flour mill, feed mill, warehouse, etc. Estimated cost, $400,000. L. R. Veatch, 428 Pratt St., Engr.

Pa., Braddock—B. Markovitz Baking Co., 1019 Talbot Ave., has awarded the contract for the construction of a 3 story, 70 x 75 ft. bakery on Talbot Ave. Noted Sept. 22.

Pa., Philadelphia — T. Bernstein & Sons, Inc., 1401 North 3d St., have awarded the contract for the construction of a 4 story, 58 x 60 ft. woodworking factory. Estimated cost, $48,000.

Pa., Philadelphia—Co.-Ed Knitting Mills, 1542 Frankford Ave., has awarded the contract for the construction of a 2 story 47 x 110 ft. factory on 5th and Courtland Sts. Estimated cost, $26,000.

Pa., Philadelphia—The La France Mills have awarded the contract for the construction of a 3 story, 50 x 61 x 72 ft. knitting mill at 4423 Frankford Ave. Estimated cost, $25,000.

Pa., Philadelphia — Mayer Baking Co., 60th and Naudain Sts., has awarded the contract for the construction of a 3 story, 93 x 115 ft. bakery on 55th St. and Thompson Ave. Estimated cost, $15,000.

Pa., Pittsburgh—Kingan & Co., 1121 Penn Ave., has awarded the contract for the construction of a 4 story, 48 x 100 ft. meat storage plant and warehouse on Penn Ave. Estimated cost, $100,000.

Pa., Pittsburgh—The North Pole Ice Co., 1218 West Carson St., has awarded the contract for the construction of a 7 story, 160 x 192 ft. ice storage plant on Carson St. Estimated cost, $400,000. Noted Sept. 8.

Pa., Pottstown—The Hydro United Tire Co. has awarded the contract for the construction of a 2 story, 134 x 170 ft. auto tire manufacturing plant. Estimated cost, $100,000.

MIDDLE WEST STATES

Ill., Peoria — The Capitol Laundry Co., c/o N. Madigan, Secy., 108 South Madison St., is having plans prepared for the construction of a 2 story, 50 x 150 ft. laundry. Estimated cost, $50,000. H. B. Dox, Lehmann Bldg., Archt.

O., West Park—The F. & S. Paint and Varnish Co., Elmwood Rd., has awarded the contract for the construction of a 3 story, 50 x 70 ft. factory. Estimated cost, $50,000.

Wis., Kaukauna—The Valley Pulp Co., is having plans prepared for the construction of a pulp mill with 30 ton capacity. O'Keefe & Orbison, College Ave., Appleton, Archts. and Engrs.

Wis., Milwaukee—Luick Ice Cream Co., Ogden Ave. and Jackson St., has awarded the contract for the construction of a 5 story, 60 x 60 ft. factory on Ogden Ave. Estimated cost, $75,000.

Wis., Neenah—The Dairymen's Storage Co., c/o H. Krumrey, Plymouth, plans to construct a 3 story, 40 x 60 ft. cold storage plant here. Estimated cost, $45,000. Architect not selected.

Wis., Rib Lake—The Rib Lake Chair and Manufacturing Co. plans to build a 2 story, 60 x 85 ft. chair factory on Main St. Estimated cost, $35,000. Architect not selected.

Wis., Waupun—The Paramount Knitting Co. has awarded the contract for the construction of a 2 story, 52 x 180 ft. addition to its factory. Estimated cost, $30,000.

WEST OF THE MISSISSIPPI

Mo., Kansas City—The Artzcraft Broom Co., 1423 Kansas Ave., has awarded the contract for the construction of a 2 story, 65 x 127 ft. factory on 14th and Kansas Aves. Estimated cost, $75,000. Noted Oct. 20.

Mo., St. Louis—The Sieloff Packing Co., c/o E. Sieloff, Pres., 4339 Natl. Bridge Rd., has awarded the contract for the construction of a 2 story, 120 x 120 ft. cooling cellar on Sacramento and Newstead Sts. Estimated cost, $75,000.

CANADA

Ont., Preston—E. B. Salyerds plans to rebuild his wood specialty plant which was recently destroyed by fire. Estimated cost, $50,000.

B. C., Prince Rupert—Prince Rupert Pulp & Paper Co., 602 Pacific Bldg., Vancouver, plans to construct first unit of pulp mill, here, to have 40 ton daily capacity. Estimated cost, $1,000,000. Engineer not selected.